PHYSICS

Name: ....

Class: ....

Remember Some Rules

Geometric Shape	Circumference (Perimeter)	Area	Volume
Cuboid (Rectangular Base)	2L+2W	$L \times W$	$L \times W \times H$
Cube (Squared Base)	4L	L^2	L^3
Circle	$2\pi r$	πr^2	-----
Sphere	-----	$4\pi r^2$	$\frac{4}{3}\pi r^3$
Cylinder (Circular Base)	$2\pi r$	πr^2	Area $\times$ Height $\pi r^2 \times h$

Some Conversions

Length	Cm $\xrightarrow{\div 100}$ m	Cm $\xrightarrow{\times 10^{-2}}$ m
Length	mm $\xrightarrow{\div 1000}$ m	mm $\xrightarrow{\times 10^{-3}}$ m
Length	Km $\xrightarrow{\times 1000}$ m	Km $\xrightarrow{\times 10^{3}}$ m
Area	Cm² $\xrightarrow{(\div 100)^2}$ m²	Cm² $\xrightarrow{\times 10^{-4}}$ m²
Area	mm² $\xrightarrow{(\div 1000)^2}$ m²	mm² $\xrightarrow{\times 10^{-6}}$ m²
Volume	Cm³ $\xrightarrow{(\div 100)^3}$ m³	Cm³ $\xrightarrow{\times 10^{-6}}$ m³
Volume	mm³ $\xrightarrow{(\div 1000)^3}$ m³	mm³ $\xrightarrow{\times 10^{-9}}$ m³

mm³ $\xrightarrow{\times 10^{-3}}$ Cm³ $\xrightarrow{\times 10^{-3}}$ Liter $\xrightarrow{\times 10^{-3}}$ m³

Time	Hour $\xrightarrow{\times 60}$ min $\xrightarrow{\times 60}$ sec
Mass	g $\xrightarrow{\div 1000}$ Kg Or g $\xrightarrow{\times 10^{-3}}$ Kg

Some Physical Quantities and their Units

Physical Quantity	Relation (Law)	Unit	Dimensional formula
Mass (m)	$mass = \dfrac{Weight}{g}$	kg	M
Length (L)		m	L
Time (t)		Sec.	T
Area (A)	$Area = Length \times width$	m^2	L^2
Volume $(V)_{ol}$	$Volume = Length \times width \times hight$	m^3	L^3
Velocity	$Velocity = \dfrac{Displacement}{Time}$	m/s	LT^{-1}
Acceleration	$Acceleration = \dfrac{Change\ in\ velocity}{Time}$	m/s^2	LT^{-2}
Momentum	$Momentum = Mass \times Velocity$	Kg.m/s	MLT^{-1}
Force	$Force = Mass \times Acceleration$	$Kg.m/s^2$ (Newton)	MLT^{-2}
Weight(F_g) Force of gravity	$Weight = Mass \times Acc.$ due to gravity (g)	$Kg.m/s^2$ (Newton)	MLT^{-2}
Work (Energy)	$Work = Force \times Displacement$	$Kg.m^2/s^2$ (N.m) (Joule)	ML^2T^{-2}
Density	$Density = \dfrac{Mass}{Volume}$	Kg/m^3	ML^{-3}

Fluids

They are the materials which can flow and have indefinite shape.

★ Types of fluids:

1-Liquids which are characterized by:

-Definite volume   -smooth flow   -Incompressible

2- Gases which are characterized by:

-Occupying any space and take the volume of its container.

-Can be easily compressed.

★ From properties of fluids:

1-Density   2-Pressure

Density

It is the mass of unit volume of a substance.

Density(ρ) = $\dfrac{mass\,(m)}{volume(V_{ol})}$

-The measuring unit is (kg/m³).

Slope $= \dfrac{m}{vol} = \rho$

Some conversions

* g/cm³ $\times 10^3$ kg/m³   * Liter $\times 10^{-3}$ m³   * cm³ $\times 10^{-6}$ m³
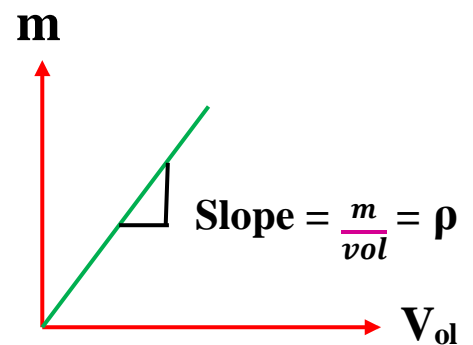
-Note: When mixing two or more materials then:

$m_{(mix)} = m_1 + m_2 + \ldots\ldots$

$\therefore \rho\, V_{ol\,(mix)} = \rho_1\,(V_{ol})_1 + \rho_2\,(V_{ol})_2 + \ldots\ldots$

$V_{ol\,(mix)} = (V_{ol})_1 + (V_{ol})_2 + \ldots\ldots$

$\left(\dfrac{m}{\rho}\right)_{mix} = \dfrac{m_1}{\rho_1} + \dfrac{m_2}{\rho_2}$

Factors that affect the density:

1-Atomic weight of the element or the molecular weight of the compound.

2-The distance between atoms or molecules.

G.R

1- **Density** is considered a characteristic property for the material.

➡ Because it changes by changing the type or the temperature of the material but not by changing its mass or volume.

2-Density of a material changes as the temperature changes.

➡ Because as the temperature changes the intermolecular distances change and so the density changes.

★Applications on Density:

➡**1-Indicating how well the battery of the car is charged:**
-Scientific idea

Measuring the density of the electrolyte solution inside it.

-Explanation: When the battery is discharged, the density of its electrolyte solution decreases and when the battery is recharged the density of electrolyte increases again.

G.R -Density of the electrolyte solution decreases during

discharging the battery.

➡ Due to the chemical reaction between the sulphuric acid and the lead plates and formation of lead sulphate.

2- Diagnosis of some diseases like (Anemia):

-Scientific idea ➡ Measuring blood density

G.R

Explanation: The normal density of the blood ranges from 1040 kg/m³ to 1060 kg/m³, So if the blood density preceded 1040 kg/m, This indicates decreases in the concentration of the red blood cells which indicates anemia.

3-<u>Determining the concentration of salts in urine:</u>

-<u>Scientific idea</u> ➡ Measuring the urine density.

G.R -Some diseases can be diagnosed by measuring the density of urine.

➡ Because some diseases increase the ratio of salts in urine above the normal rate that increases its density.

★The normal density of urine is 1020 kg/m³.

The relative density (specific weight)

It is the ratio between the density of the material to the density of water at the same temperature.   **OR**

It is the ratio between the mass of a certain volume of a material to the mass of the same volume of water at the same temperature.

Relative density of a substance $= \dfrac{\text{density of the material at certain temperature}}{\text{density of water at the same temperature}}$

Relative density of a substance $= \dfrac{\text{mass of a certain volume of a material at certain temperature}}{\text{mass of the same volume of water at the same temperature}}$

$$\rho_r = \frac{\rho_{material}}{\rho_{water}} = \frac{m_{material}}{m_{water}}$$

$\rho\,\text{material} = \rho\,\text{relative} \times \rho\,\text{water} = \rho\,\text{relative} \times$

★G.R: Relative density has no measuring unit:

➡ **Because it is a ratio between two similar quantities.**

Class Sheet

1- A tank contains a quantity of gasoline that has a mass of 3450 kg and a volume of 5 m³, so the density of gasoline is……….
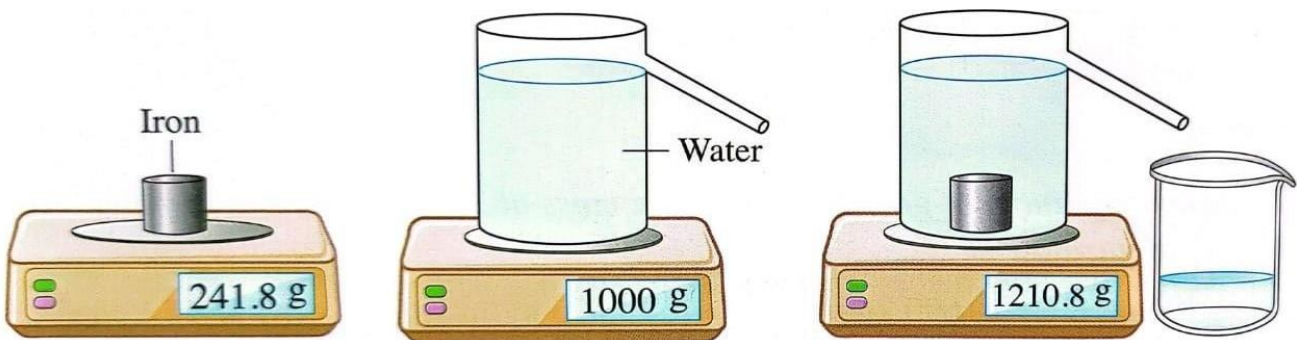
a) 720 Kg/m^3 b) 690 Kg/m^3

c) 3.455 Kg/m^3 d) 17.25 Kg/m^3

2- The opposite figure represents a solid cylinder of mass 10 kg and height 10 cm made of a substance of density 8700 kg/m³, so the radius of the cylinder base approximately equals. (Given that: The volume of a cylinder = $\pi r^2 h$)

a) 0.06 cm   b) 4.5 cm

c) 6 cm   d) 10.5 cm
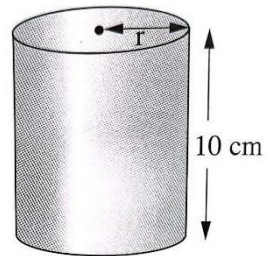
3- By using the following figures, the density of iron is………. (Given that: ρ_{water} =1000 kg/m³)

a) 7800 Kg/m^3 b) 7900 Kg/m^3

c) 8100 Kg/m^3 d) 8300 Kg/m^3

4- A cuboid of steel with a mass of 500 g and dimensions as shown in the opposite figure contains a cylindrical cavity of regular cross-section. If the density of the steel is 8 g/cm³ then the cross-sectional area of the cavity equals……….
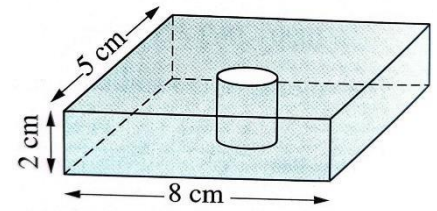
a) 7.25 cm^2 b) 7.75 cm^2

c) 8.25 cm²   d) 8.75 cm^2

5- 50 m³ of water, whose density is 1000 kg/m³, was mixed with 40 m³ of a liquid of density 800 kg/m³ to make a solution whose total volume equals the sum of the volumes of the liquids before mixing. Then, the density of the solution approximately equals……….

a) 1800 kg/m³   b) 1128 kg/m³

c) 911 kg/m³   d) 8846 kg/m^3

6- Two metals x, y have densities ρ and 2ρ respectively, if two volumes of them are required to be mixed to form an alloy, which of the following ratios of the two volumes can be mixed to obtain an alloy with the largest density, ignoring the change in the total volume when forming the alloy?

	The volume of metal (x)	The volume of metal (y)
(a)	1	1
(b)	2	1
(c)	3	2
(d)	2	3

7- If the density of aluminum is 2700 kg/m³ and the density of water at the same temperature is 10^3 kg/m³, then:

(i) The relative density of aluminum equals.........

a) 0.27   b) 0.54

c) 2.7   d) 5.4

(ii) The mass of an aluminum piece of volume 0.1 m^3 equals……….

a) 135 kg   b) 270 kg

c) 540 kg   d) 810 kg

8- A beaker is filled with 50 g of a liquid so that its mass with the liquid becomes 80 g. And after evacuating the beaker and refilling it with distilled water of density 1000 kg/m³, the mass of the beaker and water together becomes 60 g. Then, the density of the liquid is………….
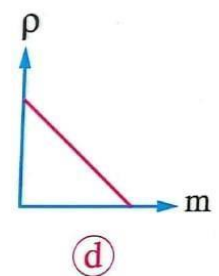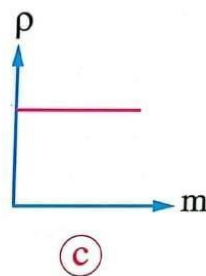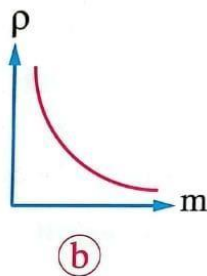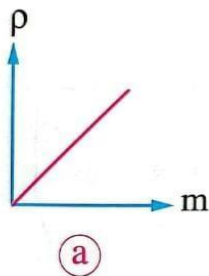
a) 600 kg/m³

b) 1260 kg/m³

c) 1667 kg/m³

d) 2600 kg/m³

Homework

1- From the units of measuring density………..

a) $N.m^{-3}$

b) $g.mm^{-1}$

c) $Kg.cm^{-2}$

d) $g.cm^{-3}$

2- The graph that represents the relation between the density of iron and the masses of solid iron pieces at constant temperature is………….

3- The opposite figure shows a solid cube of a certain material with a side length 2 cm placed on a scale so that it shows a reading of 21.6 g, then the density of the cube's material is equal to………

a) 2.7 g/cm³

b) 3.6 g/cm³

c) 5.4 g/cm³

d) 10.8 g/cm³
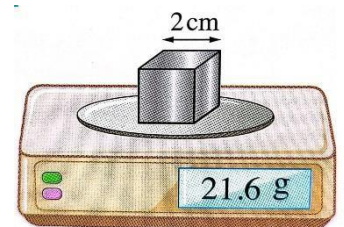
4- The following table shows the specifications of two solid cubes A, B that are made of two different materials, then mass x equals……….

| Cube	The length of the side (l)(m)	The density of the cube's material (ρ) (kg/m³)	The mass (m) (kg)
A	0.01	ρ	0.008
B	0.02	2 ρ	X

a) 0.05 Kg

b) 0.09 Kg

c) 0.128 Kg

c) 0.145 Kg

5- A volume V_{ol} of a liquid of density ρ is poured into a vessel, if another quantity of the same liquid of volume 2 V_{ol} is added into the vessel, the density of the liquid becomes………….

a) $\frac{1}{2}\rho$

b) ρ

c) $\frac{3}{2}\rho$

d) 2 ρ

6- The diagram shows an experiment to find the density of a liquid, then the density of the liquid is……..
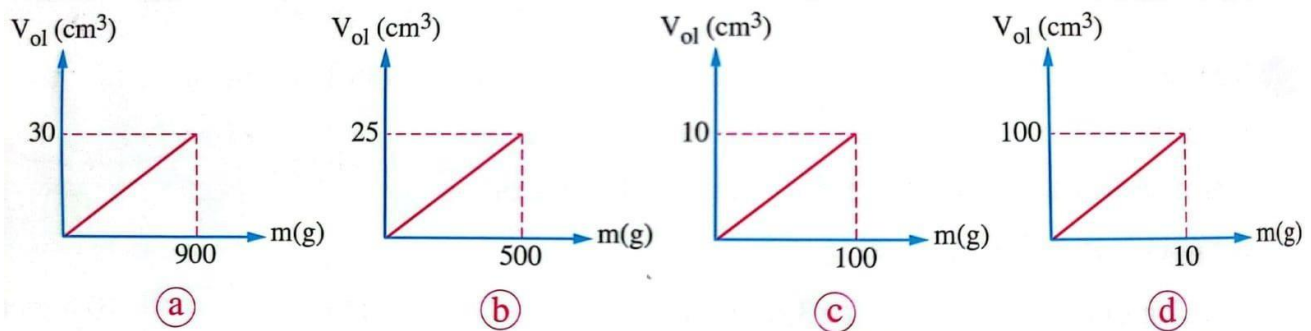
a) 0.5 g/cm³

b) 0.6 g/cm³

c) 0.8 g/cm³

d) 1 g/cm³
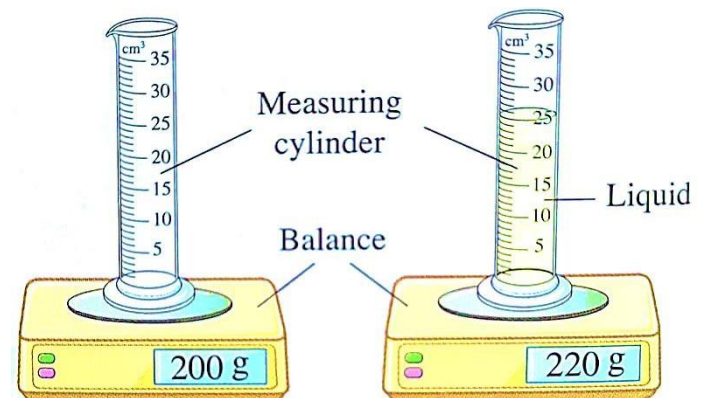
7- Two bodies (a, b) are made with equal masses of two different materials of densities 3 g/cm³ and 4 g/cm³ respectively, so the ratio between their volumes $(\frac{(v_{ol})_a}{(v_{ol})_b})$ equals ………….

a) $\frac{1}{3}$

b) $\frac{4}{3}$

c) $\frac{3}{4}$

d) $\frac{1}{4}$

8- The ratio of the density of the electrolytic solution inside a car battery after discharging the battery to its density after recharging the battery is …………..

a) greater than 1   b) equal to 1

c) less than 1   d) indeterminable

9- Which of the following graphs represents the relation between the masses and the volumes of solid pieces of a metal of density 10^4 kg/m³?

V_{ol} (cm³) V_{ol} (cm³) V_{ol} (cm³) V_{ol} (cm³)

30   25   10   100

m(g)   m(g)   m(g)   m(g)

900   500   100   10

(a)   (b)   (c)   (d)

**10- The opposite figure shows the dimensions of two solid cubes (1), (2) that are made of copper, if the weight of cube (1) is w, then the weight of cube (2) equals…….**

a) 2w   b) 4w

c) 8 w   d) 16 w

(1)   (2)
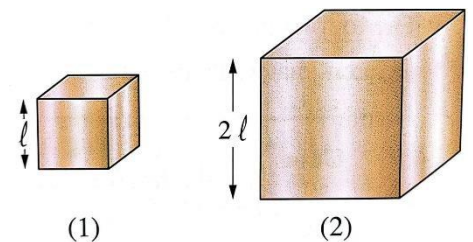
11- The opposite graph shows the relation between mass (m) and density (ρ) for equal volumes (V_{ol}) of different materials, so the value of this volume (V_{ol}) is…………

a) 10 cm³   b) 20 cm³

c) 30 cm³   d) 40 cm³

$m \times 10^{-2}$ (kg)

10

7.5

5

2.5

1.25   2.5   3.75   5 $\rho \times 10^3$ (kg/m³)
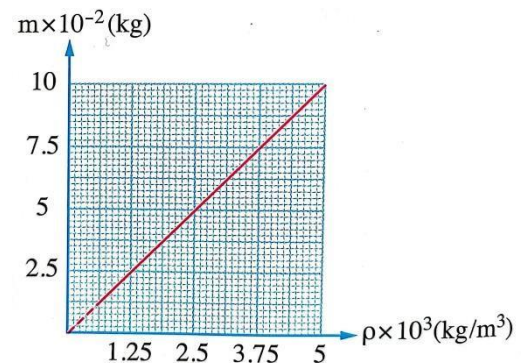
12- The following figures represent four solid bodies of different materials having equal masses, so which body has the least material density?
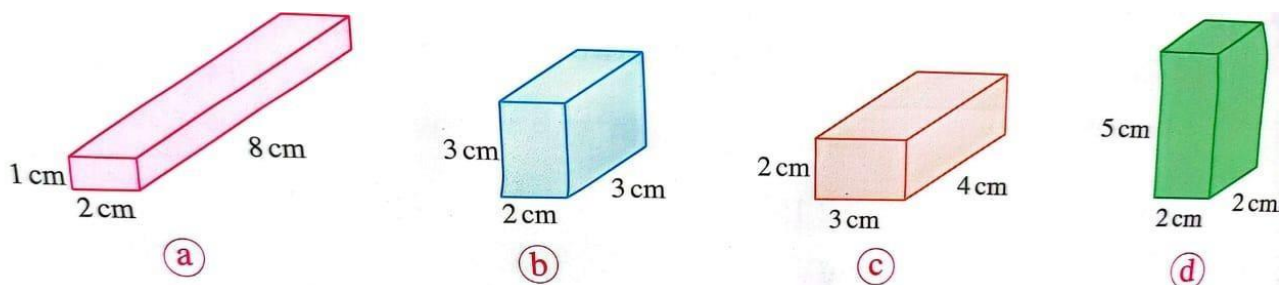
13- The following table shows the densities of some substances at the same temperature:

Substance	Mercury	Copper	Iron	Water	Kerosene
Density (g/cm³)	13.6	8.9	7.9	1	0.87

Which of the following statements is correct?

a) Volume of 1 g of mercury is greater than the volume of 1 g of copper.

b) Volume of 1 g of iron is less than the volume of 1 g of copper.

c) Mass of 1 cm^3 of mercury is greater than the mass of 1 cm^3 of any other substance in the table.

d) Mass of 1 cm^3 of water is less than the mass of 1 cm^3 of any other substance in the table.

14- Given that density of ice is X g/L and the density of water at 0°C is Y g/L, so the change a in the volume of a piece of ice of mass m when it melts at 0° C is ………..

a) mY (X–Y)

b) m (Y–X)

c) m $(\frac{1}{Y} - \frac{1}{X})$

d) $\frac{Y-X}{X}$

**15- The opposite graph represents the relation tween mass (m) and volume (V$_{ol}$) for several pieces of copper, so the density of copper is…………..**

a) 6800 kg/m^3

b) 7800 kg/m^3

c) 8600 kg/m³

d) 8700 kg/m³
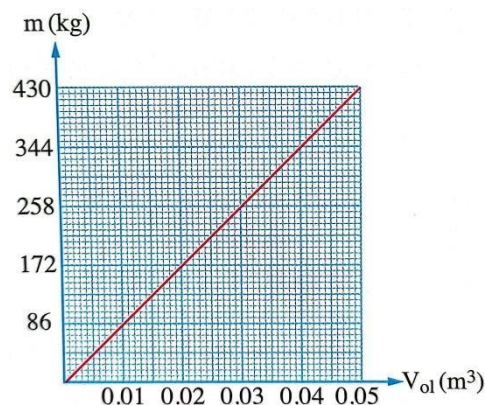
16- The opposite figure represents the graphical relation between mass (m) and volume (V_{ol}) for two materials x,y , then the ratio between the densities of the two materials ($\frac{\rho x}{\rho y}$) equals …………..

a) 0.46

b) 2.15

c) $\frac{1}{\sqrt{3}}$

d) $\sqrt{3}$
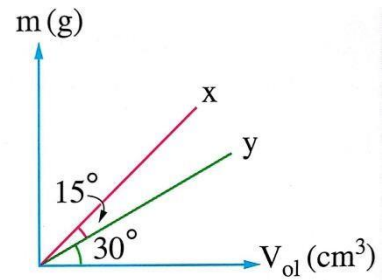
17- In the opposite figure, both groups of balls have the same mass where one group is made of metal (x) and the other group of metal (y). If all balls are solid and have equal volumes, the ratio between the densities of the two metals ($\frac{\rho x}{\rho y}$) is ……………

a) $\frac{3}{5}$

b) $\frac{5}{3}$

c) $\frac{1}{1}$

d) $\frac{8}{3}$
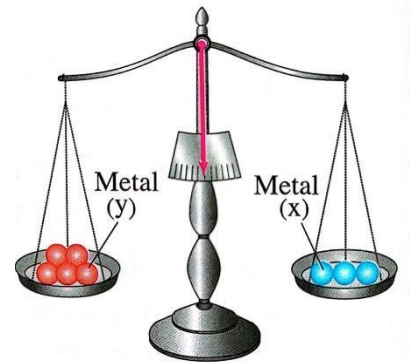
18- The opposite table shows some values of the density of water at different temperatures:

Temperature (°C)	Water density (kg/m³)
3.98	1000
10	999.7
25	997.1
100	958.4

(i) At which temperature does a cubic meter of water have the greatest mass?

a) 3.98 °C

b) 10 °C

c) 25 °C

d) 100 °C

(ii) At which temperature does one kilogram of water have the largest volume?

a) 3.98°C

b) 10°C

c) 25°C

d) 100°C

19- If the price of 1 g of gold is 1000 pounds, then the side length (l) of a solid cube made of gold of 1 million pound equals…………. (Where: The density of gold is 19.3×10^3 Kg/m³)

a) 0.01 cm

b) 1 cm

c) 2 cm

d) 3.7 cm

20- Two solid balls are made of different materials, the first has radius r and density ρ and the second has radius 2 r and density 2ρ, so the ratio between their masses $(\frac{m_1}{m_2})$ equals……….

a) $\frac{1}{2}$ b) $\frac{1}{4}$

c) $\frac{1}{8}$ d) $\frac{1}{16}$

21- The opposite figure shows a cube and a cylinder. If both are made of solid iron, the ratio between the mass of the cube to that of the cylinder $(\frac{m_{cube}}{m_{cylinder}})$ is…………
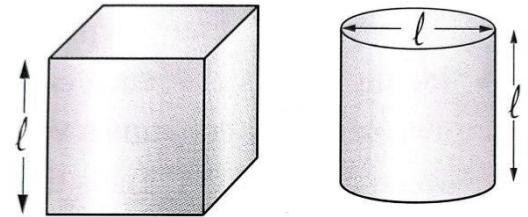
(Where: The volume of the cylinder $= \pi r^2 h$)

a) $\frac{1}{\pi}$ b) $\frac{2}{\pi}$

c) $\frac{4}{\pi}$ d) 1

22- If the relative density of wood is 0.6, then: (Where: $\rho_w = 1000$ kg/m³)

(i) The density of wood equals……………

a) 300 kg/m³ b) 600 kg/m³

c) 1200 kg/m³ d) 1666.67 kg/m³

(ii) The mass of a piece of wood of volume 0.1 m³ is……….

a) 30 kg b) 60 kg

c) 600 kg d) 1200 kg

23- A beaker has a mass of 230 g when it is empty. If its mass when it is filled with water is 700 g and when it is filled with oil is 600 g, then: (Given that: $\rho_w = 1000$ kg/m³)

(i) The relative density of oil equals…………

a) 1.27 b) 1.25

c) 0.8 d) 0.787

(ii) The capacity of the beaker equals………….

a) 470 cm³ b) 500 cm³

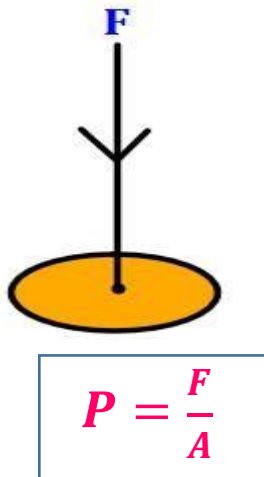c) 2000 cm³ d) 2128 cm³

Pressure

It is the average force acting perpendicularly on a unit area surrounding this point.
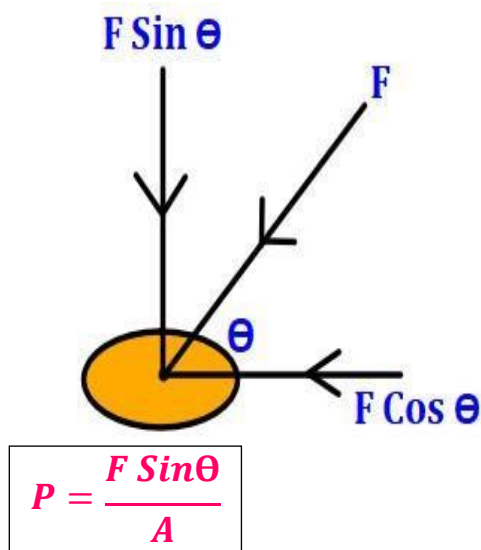
★Finding pressure at a point:

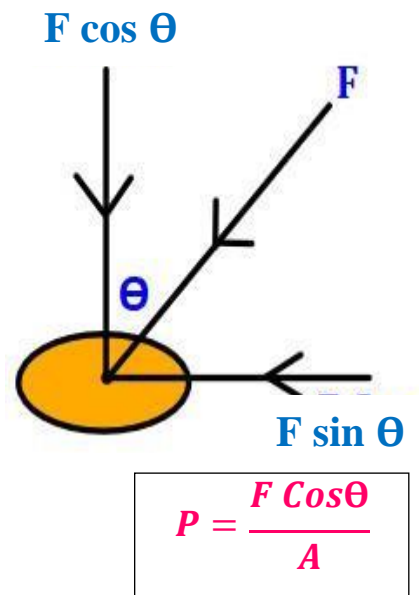-When the force:

-(a) perpendicular To the surface.	(b) making an angle (Ө) with the surface.	(c) making an angle (Ө) with the normal

F

$$P = \frac{F}{A}$$

F Sin Ө

F

Ө

F Cos Ө

$$P = \frac{F\ Sin\Theta}{A}$$

F cos Ө

F

Ө

F sin Ө

$$P = \frac{F\ Cos\Theta}{A}$$

★ The measuring unit of pressure is:

1- (N/m^2)

2- (Pascal)
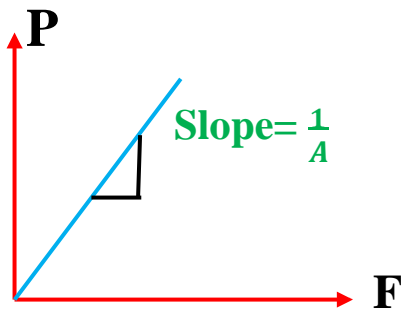
3- $(kg/m.s^2)$

4- (J/m^3)

5- (Bar)

6- (Torr)

7- (m Hg)

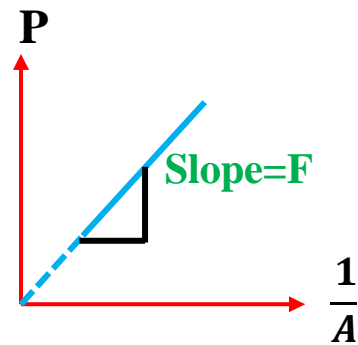8- (atm.)

★Factors affecting the pressure at a point:

a) The average force acting Perpendicularly (F):

-Directly proportional.

P

Slope= $\frac{1}{A}$

F

b) Area surrounding the point.

-Inversely proportional.

P

Slope=F

$\frac{1}{A}$

$$\frac{P_1}{P_2} = \frac{F_1}{F_2} \times \frac{A_2}{A_1}$$

★G.R: Tires of heavy trucks are wide.

➡ Because ($P \alpha \frac{1}{A}$) so by increasing the area the pressure due to the weight of the car on the road decreases. So, the tires do not sink in sand roads.

★G.R: The sewing needle has a very sharp tip:

➡ Because ($P \alpha \frac{1}{A}$) so when the tip is very sharp very high pressure is produced and the needle penetrates the cloth easily.

★Applications on the pressure:

1-Measuring blood pressure:

-Normal person has two values for blood pressure:

(A) Systolic pressure (contracting

(B) The diastolic (relaxing)

(A) Systolic pressure (contracting

It is the maximum value for the blood pressure when the heart muscle contracts and equal 120 Torr for the normal person.

(B) The diastolic (relaxing)

It is the minimum value for blood pressure when the heart muscles relaxes and equal 80 Torr for the normal person.

2-Measuring the air pressure inside the tires of a car:

★G.R: The tyre of the car is filled with air under a suitable high pressure:

➡ To decrease the tangent area between the tire and the road, so the friction between them decreases and so on the temperature produced due to the friction decreases.

Examples

1- A force of 25 N acted on a surface of area 5 cm², then the pressure affecting the surface if:
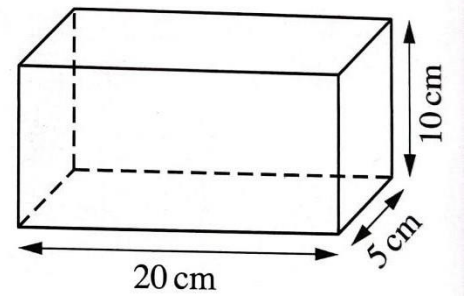
(i) The force was perpendicular to the surface equals…………

a) 2.5×10^4 N/m²   b) 3×10^4 N/m²

c) 4.33×10^4 N/m²   d) 5×10^4 N/m²

(ii) The force was making an angle of 60° with the surface equals……………

a) 2.5×10^4 N/m²   b) 3×10^4 N/m²

c) 4.33×10^4 N/m²   d) 5×10^4 N/m²

2- The opposite figure shows a solid cuboid whose material's density is 5000 kg/m³, that is placed on a horizontal surface, then: (Where: g = 10 m/s²)

(i) The highest pressure that can be produced using that cuboid on the surface equals………….

a) 10^2 N/m²   b) 10^3 N/m²

c) 10^4 N/m²   d) 10^6 N/m²

20 cm

10 cm

5 cm

(ii) The lowest pressure that can be produced using that cuboid on the surface equals

a) 2.5×10^5 N/m²   b) 0.25×10^4 N/m²

c) 2.25×10^2 N/m²   d) 0.25 N/m²

3- A car has a mass of 1200 kg, each of its four tyres has a contact area with the ground that equals 80 cm². Then, the pressure by which the car affects the ground is…………

a) 3.675×10^5 Pa   b) 7.88×10^5 Pa   **(Where: g = 9.8 m/s²)**

c) 1.47×10^6 Pa   d) 2.94×10^6 Pa

4- If the pressure which affects the ground due to the standing of a girl on her both feet equals 2.5×10^5 N/m², so the pressure on the ground due to the standing of the same girl on one foot becomes…………

a) 7.5×10^4 N/m²   b) 2.5×10^5 N/m²

c) 5×10^5 N/m²   d) 10^6 N/m²

Homework

1- Pressure is measured in………..

a) Kg s^{-2} b) Kg.m^{-1}.s^{-2}

c) N.m^{-1} d) N.m^2

2- In which of the following figures the pressure exerted by the weight of the child on the ground is the lowest?

| a | b | c | d |

3- Fish tank of base area 1000 cm² containing water of weight 4000 N while being placed on a horizontal surface, so the pressure of water at the bottom of the tank equals..........

a) 400 N/m²   b) 4000 N/m²

c) 4×10^4 N/m²   d) 4×10^6 N/m²

4- A force of 15 N acted on a surface of area 2 cm² such that the vector of the force makes an angle of 30° with the normal to the surface, so the pressure acted on the surface equals..........

a) 1.875×10^4 N/m²   b) 3.248×10^4 N/m²

c) 37.5×10^3 N/m²   d) 64.95×10^3 N/m²

5- A solid cuboid of dimensions 10 cm, 5 cm, 2.5 cm and mass 1 kg is placed on a horizontal plane surface. Then: (Where: g = 10 m/s²)

(i) The density of the cuboid material equals............

a) 8000 kg/m³   b) 6400 kg/m³

c) 5600 kg/m³   d) 4200 kg/m³

(ii) The highest pressure by which the cuboid could affect the surface equals..........

a) 42000 N/m²   b) 4000 N/m²

c) 8000 N/m²   d) 10000 N/m²

(iii) The lowest pressure by which the cuboid could affect the surface equals..........

a) 2000 N/m²   b) 4000 N/m²

c) 8000 N/m²   d) 10000 N/m²

6- The opposite figure shows a chair whose legs are put in protector caps to protect the carpet under the chair, which of the following choices represents the effect of putting the caps on the area of contact between the legs and the carpet and the pressure on that area?
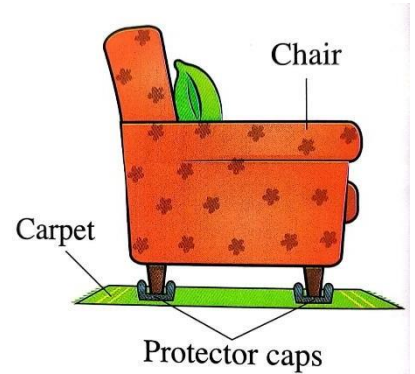
	Area of contact	Pressure
(a)	Decreases	Decreases
(b)	Decreases	Increases
(c)	Increases	Decreases
(d)	Increases	Increases

Chair
Carpet
Protector caps

7- A brick is placed horizontally on a horizontal surface as in figure (1), if its orientation is changed to be as in figure (2), which of the following choices represents the effect of this change on each of the force and the pressure due to the brick on the contact surface?
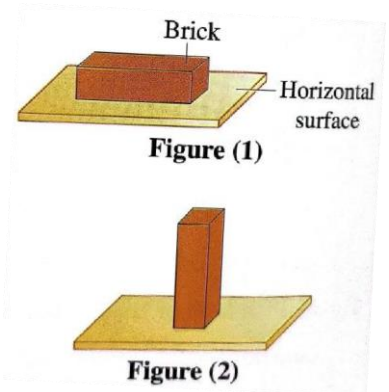
	The force	The Pressure
(a)	Increases	Decreases
(b)	Increases	Remains constant
(c)	Remains constant	Increases
(d)	Remains constant	Remains constant

Brick
Horizontal surface
Figure (1)
Figure (2)

8- Plane surfaces have different areas, each of them is affected by a different force as shown in the following figures, so in which figure the pressure exerted on the surface is the greatest?

F
A
(a)

2 F
2 A
(b)

3 F
3 A
(c)

$\frac{3}{2}$ F
$\frac{1}{2}$ A
(d)
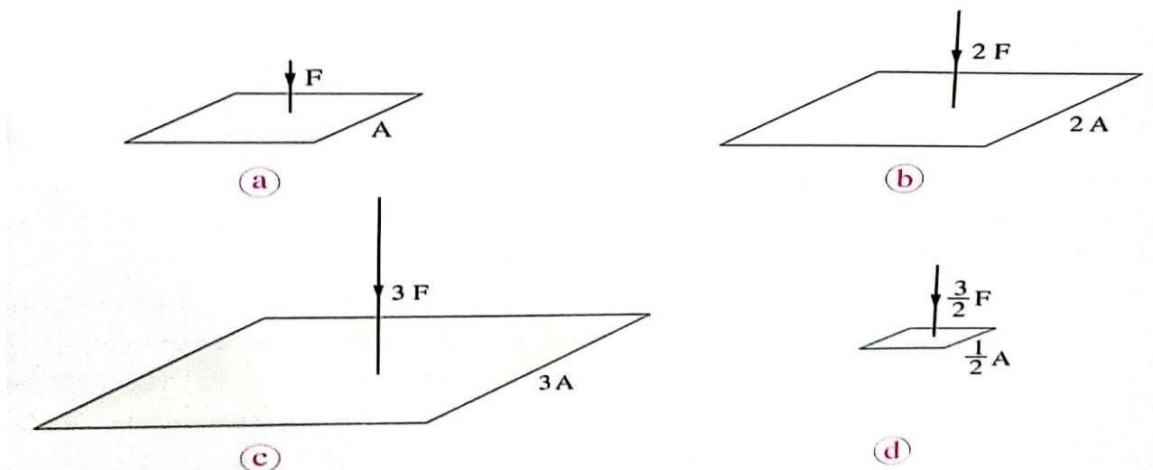
9- Which of the following graphs represents the relation between the pressure (P) acting on a surface of area 2 m² and the force (F) causing that pressure?

P(N/m²)	P(N/m²)	P(N/m²)	P(N/m²)
100 -----	200 -----	100 -----	200 -----
200 F(N)	100 F(N)	50 F(N)	500 F(N)
(a)	(b)	(c)	(d)
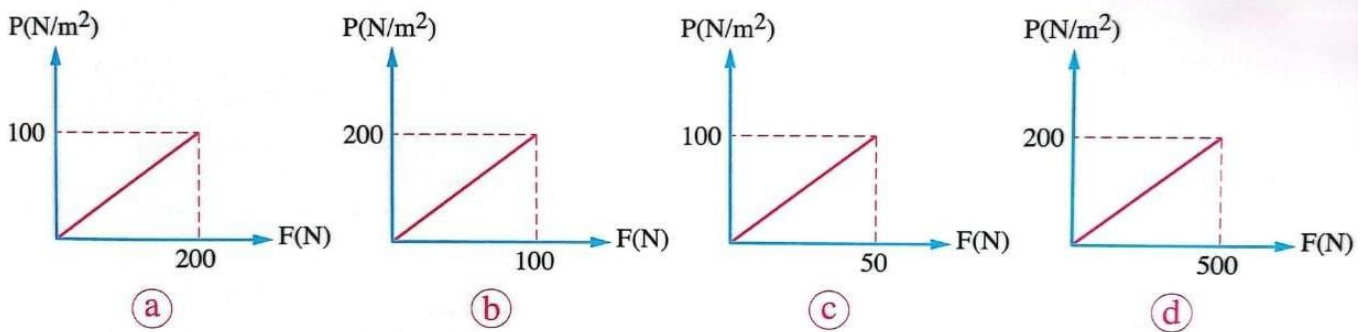
10- A submarine has a circular window whose diameter is 0.3 m. If the maximum external pressure that the window can withstand is 660 kPa, so the minimum external force that can break the window is approximately equal to……….

a) 40×10^3 N   b) 47×10^3 N

c) 40×10^3 N   b) 120×10^3 N

11- A man of weight w is standing on the ground with both of his feet. If the contact area of each foot with the ground is A, the man affects the ground with a pressure that equals ……….

a) $\frac{2w}{A}$ b) $\frac{w}{A}$

c) $\frac{w}{2A}$ b) $\frac{w}{4A}$

12- A cube of side length 10 cm and a cuboid made of the same material whose dimensions are 30 cm, 20 cm and 10 cm are placed on a horizontal surface. The face on which the cuboid can be placed on the surface to produce a pressure equal to the pressure produced by the cube is the face of dimensions…………

a) 20 cm × 10 cm   b) 30 cm × 10 cm

c) 30 cm × 20 cm   d) the pressure produced by both cannot be equal

13- A solid alloy that is in the form of a cuboid is placed on a horizontal surface where the vertical dimension is 80 cm, if the pressure of the cuboid on the surface is 15200 Pa. then the density of the alloy equals ..…………   (Take: g = 10 m/s²)

a) 1800 kg/m³   b) 1900 kg/m³

c) 2000 kg/m³   d) 2200 kg/m³

14- The opposite figure shows a hammer exerting a force F on a nail that in turn exerts the same force on a piece of wood, so the ratio between the two quantities of pressures at the two points x and y $\left(\dfrac{P_x}{P_y}\right)$ is …………….
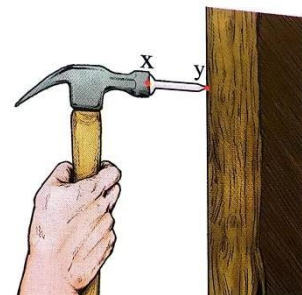
a) greater than one　　　　　　b) less than one

c) equal to one　　　　　　　　d) we can't determine the answer

15- Two solid bodies that are made of two different metals are placed on a horizontal surface as shown in the figure, if the resulted pressures due to them are equal ($P_1 = P_2$) then the ratio between the densities of the two bodies equals ………….
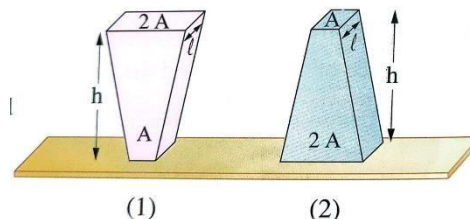
a) $\dfrac{1}{1}$　　　　　b) $\dfrac{1}{2}$

c) $\dfrac{2}{1}$　　　　　d) $\dfrac{4}{1}$

16- A man sits on a chair of four legs while his feet don't touch the ground, so if the mass of both the man and the chair together is 95 kg and the legs of the chair have circular ends, each of radius 0.5 cm, then the pressure that each leg produces on the ground equals………….

a) 2.96×10^6 Pa　　　　　b) 5.92×10^6 Pa　　　　　**(Take: g = 10 m/s²)**

a) 11.85×10^6 Pa　　　　b) 14.81×10^6 Pa

17- In the opposite figure a man holds a drawing pin between his thumb and index fingers where he presses on the head of the pin with his thumb by a force of 0.5 N without letting the tip injure him. If the area of the head of the pin is 6×10^{-5} m² then:
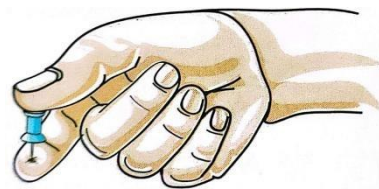
(i) The force of the tip of the pin on the index equals…………..

a) 0.5 N　　　　　　　b) 1 N

a) 2 N　　　　　　　　b) 4 N

(i) The pressure due to the head of the pin on the thumb finger is approximately equal to ………

a) 4×10^3 N/m²　　　　　b) 8×10^3 N/m²

c) 9×10^3 N/m²　　　　　d) 12×10^3 N/m²

18- A student has put 8 coins above each other on a horizontal surface as shown in figure (1). If the weight of each coin is 0.08 N and the area of its face is 53×10^{-4} m² then:

Figure (1)

(i) The pressure of these coins which acted on the surface equals …………

a) 1.21×10^3 N/m²   b) 2.41×10^3 N/m²

c) 5.71×10^3 N/m²   d) 6.21×10^3 N/m²

(ii) If the student spreads the coins on the surface as shown in figure (2), then:

Figure (2)

	The total force by which the coins act on the surface	The total pressure by which the coins affect the surface
(a)	Remains constant	Increases
(b)	Remains constant	Decreases
(c)	Decreases	Increases
(d)	Decreases	Doesn't change

19- In the opposite figure, a cuboid is placed on a horizontal surface such that the dimensions of its base are (10 cm × 5 cm), so it exerts a pressure of value P on the surface, then how will the pressure on the surface change when the cuboid is repositioned to be on the base of dimensions (20cm × 10 cm) ?
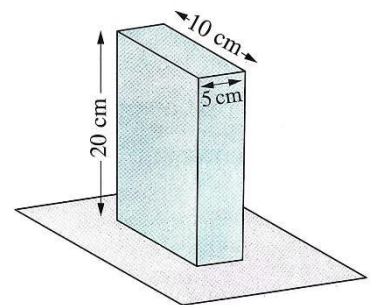
a) Increases by $\frac{P}{4}$ b) Decreases by $\frac{3P}{4}$

c) Increases by 4 P   d) Decreases by $\frac{P}{2}$

20- The opposite figure represents a solid metallic cylinder of height X and cross-sectional area A placed on a horizontal surface. If the cylinder affects the surface by pressure P, the density of the material of the cylinder equals (Given that the acceleration due to gravity is g)
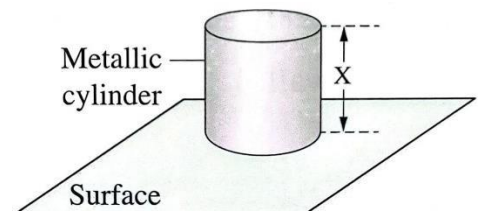
a) $\frac{gX}{P}$ b) $\frac{P}{gX}$

c) $\frac{gX}{PA}$ d) $\frac{PA}{gX}$

Pressure at a point inside a liquid

It is the weight of the liquid column, which its base is the unit area surrounding this point and its height is the vertical distance from this point to the surface of the
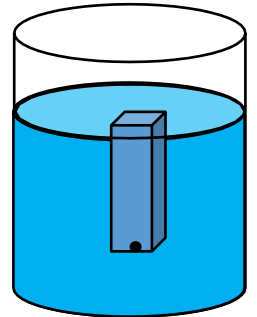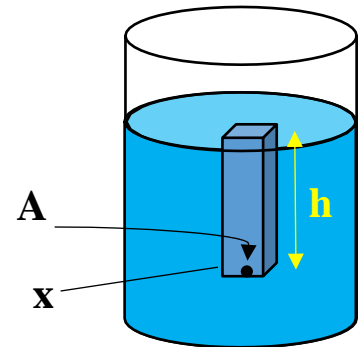
★Deduction of the Pressure value at a point inside a liquid:

-Imagine plate (X) of Area (A) at depth (h) inside a liquid of density (ρ).

-The force acting on the plate (X) is the weight of the liquid column above it.

-The weight of the liquid column (F_g) is:

- $F_g = mg$ ➡ ∵ $m = \rho V_{ol}$, $V_{ol} = Ah$

∴ $F_g = A \rho g h$ ➡ $P = \dfrac{F}{A} = \dfrac{A \rho g h}{A}$

$$∴ P = \rho\, g\, h$$

-If the liquid surface is open to air then the total pressure at this point.

$$P = P_a + \rho\, g$$

$$P_a = 1.013 \times 10^5 \text{ N/m}^2$$

Confirm units before solving

Units: -   ρ ⟹ Kg/m³   g ⟹ m/s²   h ⟹ m   Pa ⟹ N/m²

★Factors affecting the pressure at a point inside the liquid :

1-Density of the liquid (ρ):

-Directly proportional (P α ρ)

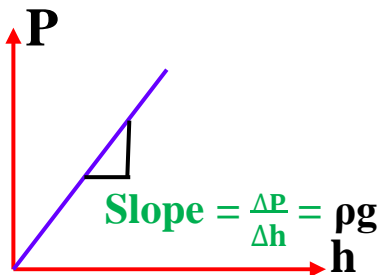Slope = $\dfrac{\Delta P}{\Delta \rho}$ = gh
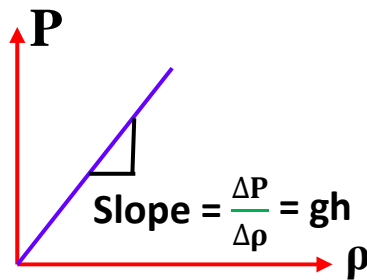
2-Acceleration due to gravity (g)

-Directly proportional (P α g)

Slope = $\dfrac{\Delta P}{\Delta g}$ = ρh
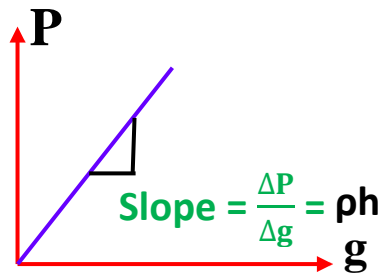
3- Point depth (h)

-Directly proportional (P α h)

Slope = $\dfrac{\Delta P}{\Delta h}$ = ρg

Liquid closed from

Slope = $\dfrac{\Delta P}{\Delta h}$ = ρg
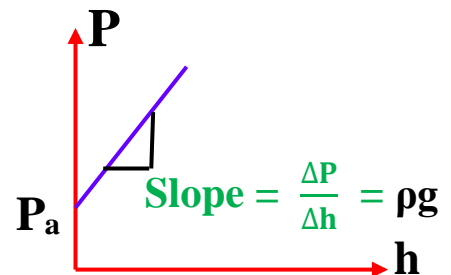
Liquid opened to air

$$\frac{P_1}{P_2} = \frac{\rho_1}{\rho_2} \times \frac{h_1}{h_2}$$

★G.R: 1) Dams are built such that they are thicker at their bases.

➡ **Because the pressure is directly proportional to the depth (h) inside the liquid so it must be thicker at its base to bear the increase in pressure which is due to the increase in depth.**
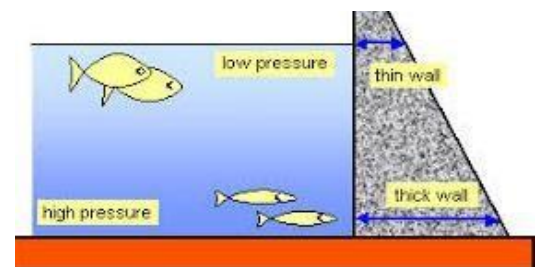
2) Pressure at all points in the same horizontal plane is the same.

➡ As the pressure at a point inside a liquid is determined from the relation (P=ρgh). So, when all points have the same depth and the same density, Then the pressure becomes the same.
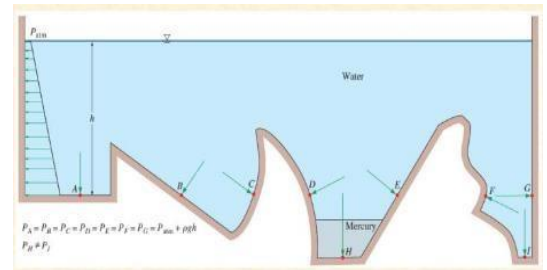
3) Sea level is the same in all open oceans and seas.

➡ Because all points lying in the same horizontal plane inside a liquid have the same pressure.

Class Sheet

1- A bowl of bottom area 1000 cm² is placed horizontally while it contains salty water of density 1030 kg/m³. If the height of water inside the bowl is 1 m and the bowl surface is open to air, then: (Take: Pa = 1.013 × 10⁵ N/m², g = 10 m/s²)

(i) The total pressure on the bottom of the bowl equals……………..

a) 2×10^3 N/m²   b) 2×10^4 N/m²

c) 9.1×10^4 N/m²   d) 1.116×10^5 N/m²

(ii) The total force that causes pressure on the bottom of the bowl equals…………..

a) 2×10^5 N   b) 10^5 N

c) 2×10^4 N   d) 1.116×10^4 N

2- A submarine dives under the surface of seawater whose density equals 1030 kg/m³. If the submarine has a circular glass porthole window of radius 20 cm whose center becomes at a depth of 50 m, then:

(i) The difference between the pressure that affects the external surface of the porthole window and the pressure that affects its internal surface equals…………. (g = 10 m/s²)

a) 6.14×10^5 N/m²   b) 5.15×10^5 N/m²

c) 3.14×10^5 N/m²   d) 2.93×10^4 N/m²

(ii) The net force that acts on the porthole window equals………..

a) 6.47×10^4 N   b) 9.71×10^5 N

c) 3.24×10^5 N   d) 3.33×10^5 N

3- A swimmer was diving vertically downward in a river as shown in the opposite figure. If the density of the water in the river was 1000 Kg/m³ then the pressure difference between points A and B equals…………
(g = 9.8 m/s²)

a) 1.96×10^3 N/m²   b) 13.52×10^3 N/m²

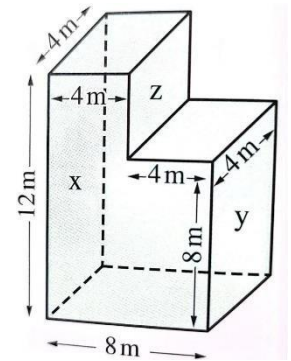c) 17.64×10^3 N/m²   d) 19.6×10^3 N/m²
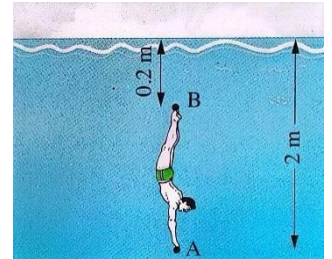
4- The opposite figure shows a reservoir filled with water. If the water surface is exposed to the atmospheric air pressure which is 10^5 N/m², then:

(Given that: The density of water = 1000 kg/m³, The acceleration due to gravity= 10 m/s²)

(i) The total pressure on the bottom of the reservoir equals…………..

a) 1.2×10^5 N/m²   b) 1.4×10^5 N/m²

c) 1.8×10^5 N/m²   d) 2.2×10^5 N/m²

(ii) The average force that water exerts on face x equals…………

a) 5.76×10^6 N   b) 2.88×10^6 N

c) 1.92×10^6 N   d) 0.96×10^6 N

(iii) The average force that water exerts on face y equals…………...

a) 1.28×10^6 N   b) 2.56×10^6 N

c) 3.2×10^6 N   d) 3.84×10^6 N

Homework

1- The water pressure at the bottom of the lake of the High Dam which affects the body of the dam depends on……………

a) area of the water surface   b) length of the dam

c) depth of the lake   d) density of the dam material

2- If the density of the seawater is 1030 kg/m³, then the depth at which water pressure equals 92 kPa is…………..

a) 8.75 m   b) 9.11 m

c) 11.5 m   d) 15.34 m

3- The opposite graph shows the relation between the pressure of a liquid (P) at a point inside the liquid and the vertical distance (h) between this point and the surface of the liquid for three liquids A, B, C, so……………

a) $\rho_C < \rho_B < \rho_A$ b) $\rho_C > \rho_B > \rho_A$

c) $\rho_C < \rho_A < \rho_B$ d) $\rho_C = \rho_B = \rho_A$
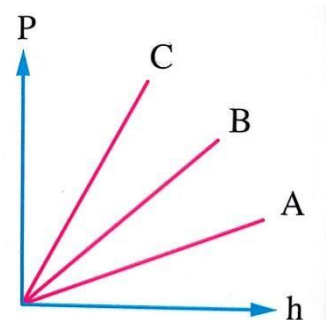
4- If the pressure of liquid A whose density is 1800 kg/m³ at a point at depth 20 cm inside it equals P, then the pressure of liquid B whose density is 1200 kg/m³ at a point at depth 60 cm inside it equals………

a) $\dfrac{P}{2}$ b) $\dfrac{3P}{2}$

c) 2 P   d) 3P

5- A conical flask contains a liquid of density 900 kg/m³ as in the opposite figure. If the liquid exerts a pressing force of 7.2 N on the base of the flask, then the liquid height (h) in the flask equals….............. (g = 10 m/s²)

a) 0.1 m   b) 0.3 m

c) 0.4 m   d) 0.8 m
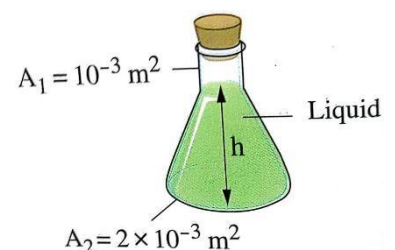
6- A glass flask that is closed from both ends contains an amount of water as in the opposite figure. When the flask is placed vertically on base x, the water pressure on base x becomes P. so if the flask is inverted vertically to be placed on base y, the pressure of water on base y will be……………

a) zero

b) less than P

c) greater than P

d) equals P
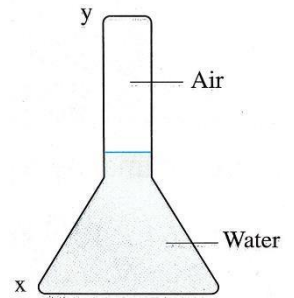
7- The opposite figure shows a cylinder (x) of base area A containing a quantity of water that affects the base of the cylinder with a pressure P. If the water is transferred completely from the cylinder to a bowl (y) that has the same base area A, then the water pressure at the base of the bowl will be…………..

a) greater than P

b) less than P

c) equal to P

d) equal to zero
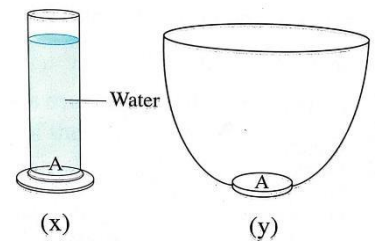
8- A jar has three holes (1,2,3) in its wall at different heights from its base, which figure of the following represents the correct shape of the water getting out from the three openings?
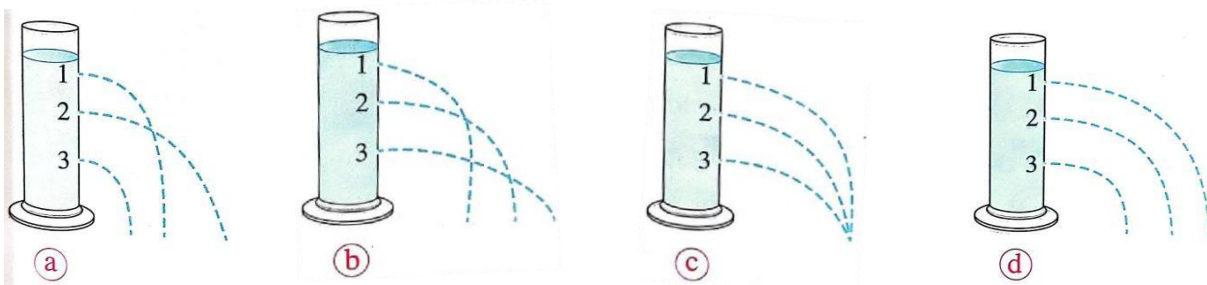
9- The opposite figure shows two adjacent open boxes, the first is in the form of a cube while the second is in the form of a cuboid. Then, the ratio between the force due to the atmospheric pressure that acts on the base of each of the two boxes from inside ($\frac{F_{cube}}{F_{cuboid}}$) equals……………

a) $\frac{1}{1}$

b) $\frac{1}{2}$

c) $\frac{1}{3}$

d) $\frac{1}{4}$
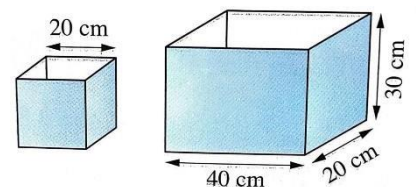
10- If the radius of the Earth is equal to 6.37×10^6 m, the average atmospheric pressure at the surface of the Earth is 1.013×10^5 Pa, the surface area of a sphere is $4\pi r^2$ and the acceleration due to gravity is 9.8 m/s² then the total mass of the atmosphere is approximately equal to………

a) 3.64×10^{15} Kg

b) 5.27×10^{18} Kg

c) 9.51×10^{20} Kg

d) 8.3×10^{19} Kg

11- The opposite figure shows two cardboard squares x and y exposed to the atmospheric pressure at the same horizontal level. If the area of square x is four times that of square y. then ratio between:


(i) the atmospheric pressure acting on square x and that acting on square y ($\frac{P_x}{P_y}$) equals.......

a) $\frac{1}{2}$

b) $\frac{1}{4}$

c) $\frac{2}{3}$

d) $\frac{1}{1}$

(ii) the force caused by the atmospheric pressure on square x and the force caused by the atmospheric pressure on square y ($\frac{F_x}{F_y}$) equals………….

a) $\frac{1}{2}$

b) $\frac{1}{4}$

c) $\frac{2}{1}$

d) $\frac{4}{1}$

12- A research submarine dives in an area of coral reefs as in the opposite figure. So, the correct order for the values of the pressure in the positions (1), (2), (3) is………..
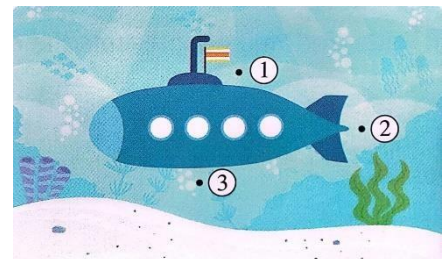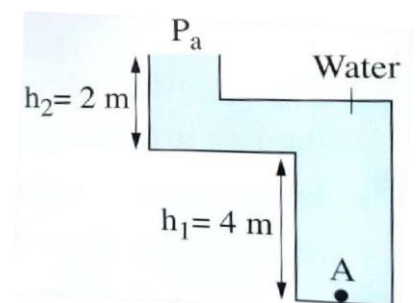

a) $P_1 < P_3 < P_2$

b) $P_1 < P_2 < P_3$

c) $P_1 > P_2 > P_3$

d) $P_1 = P_2 = P_3$

13- From the opposite figure, the total pressure at point A is…………

(Given that: The density of water = 1000 kg/m³, The acceleration due to gravity= 9.8 m/s² , Pa = 1.013×10^5N/m²)

a) 10^5 N/m²

b) 1.2×10^5 N/m²

c) 1.601×10^5 N/m²

d) 2.5×10^6 N/m²

14- Mariana Trench is the deepest trench in the world which is located in the western Pacific Ocean at depth of 11 km, if the average density of the ocean's water is 1020 kg/m³, then the pressure of water at this depth is nearly equal to............... (g = 9.8 m/s²)

a) 1.8×10^5 pascal

b) 2.2×10^6 pascal

c) 2.9×10^7 pascal

d) 1.1×10^8 pascal

15- The opposite figure shows a water sink whose depth extends from 20 cm to 30 cm, so the pressure of water that affects a stopper placed under the sink equals ....

(Given that: g = 9.8 m/s², $\rho_{water} = 1000\ Kg/m^3$)

a) 1960 pascal

b) 2450 pascal

c) 2940 pascal

d) 4900 pascal
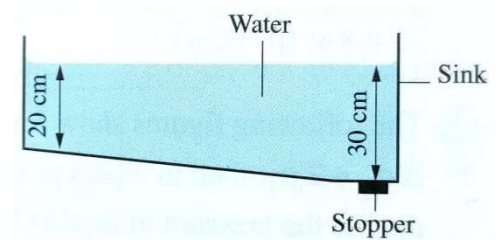
16- A glass plate of surface area 0.036 m² placed horizontally under the surface of a liquid of density 930 kg.m⁻³ . If the force that acts on the upper surface of the plate due to the liquid pressure is 290 N, the depth of the plate under the liquid surface equals.................... (g = 9.8m/s²)

a) 0.88 m

b) 1.1 m

c) 1.8 m

d) 8.7 m

17- Fish tank has a shape of cuboid whose base dimensions are 80 cm, 60 cm and its height is 40 cm. Water is poured in the tank until it has reached a height of 30 cm. The force due to the water pressure which acts on the bottom of the tank equals.......

(Given that: g = 9.8 m/s², $\rho_{water} = 1000\ Kg/m^3$)

a) 1881.6 N

b) 1232.4 N

c) 1042.6 N

d) 1411.2 N

18- submarine has settled down at depth of 400 m under seawater of density 1025 kg/m^3 , so the pressure affecting the external surface of the submarine walls is ………..

(Where: g = 9.8 m/s^2, Pa = 1.013 × 10^{5}N/m^2)

a) 4.1 × 10^5 N/m^2 b) 4.1 × 10^6 N/m^2

c) 4.2 × 10^6 N/m^2 d) 2.05 × 10^6 N/m^2

19- If the atmospheric pressure at the sea level is 100 kPa and the density of seawater is 1020kg.m^{-3} at what depth from the sea level does the total pressure equal 110 kPa   (g = 9.8m/s^2)

a) 1 m   b) 9.8 m

c) 10 m   d) 11 m

20- A cubic tank, of side length 100 cm, is open from the top. If water is poured inside the tank to a height of 20 cm then oil is added to a height of 80 cm from the bottom of the tank, so the pressure difference between a point at the surface of oil and another point at the interface between water and oil equals…………..   (Where: g = 10 m/s^2, Pa = 1.013 × 10^{5}N/m^2 , ρ_{oil} =900Kg/m^3)

a) 2 × 10^3 N/m^2 b) 5.4 × 10^3 N/m^2

c) 7.4 × 10^3 N/m^2 d) 9.2 × 10^3 N/m^2

21- The opposite figure shows three vessels, each of them contains a liquid of height h. If all the vessels are placed in the same horizontal level, so the vessel in which the weight of the liquid:

(1)   (2)   (3)
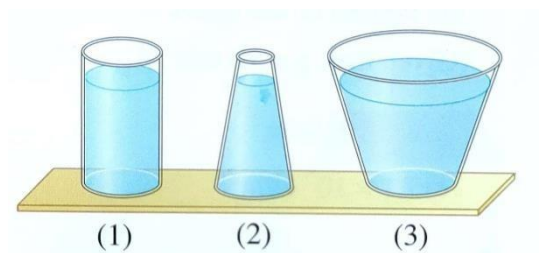
(i) equals its pressing force on the bottom of the vessel is…………

a) 1   b) 2

c) 3   d) 1 , 2 and 3

**(ii) is greater than its pressing force on the bottom of the vessel is…………**

a) 1   b) 2

c) 3   d) 1 and 2

is less than its pressing force on the bottom of the vessel is…………..

a) 1   b) 2

c) 3   d) 1 and 3

22- The opposite figure shows three points x, y, z inside a liquid that is open to atmospheric pressure. If the total pressure that affects point x is 1.5 atm. so the ratio between the total pressures at points y and z $\left(\dfrac{P_y}{P_z}\right)$ equals……………..
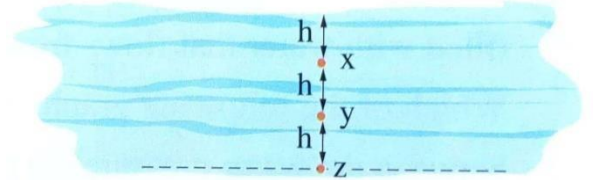

a) $\dfrac{2}{3}$ b) $\dfrac{2}{5}$

c) $\dfrac{4}{5}$ d) $\dfrac{3}{2}$

23- The opposite figure shows the heights of water and petroleum oil in a well of depth 2000 m. If the pressure of the two liquids at the bottom of the well is 17.5 MPa and the densities of both water and petroleum oil are 1000 kg.m^{-3}, 830 kg.m^{-3} respectively, so the height of the oil column (h) is nearly equal to…………
(Where: g = 10 m/s^2)

a) 907 m   b) 1000 m

c) 1091 m   d) 1471 m
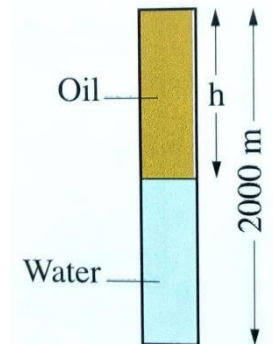
24- Water flows from a tap in a uniform rate to fill an empty tank as in the figure, then which of the following graphs represents the relation between the water pressure (P) that acts at the bottom of the tank and the elapsed time (t) till the tank gets filled?
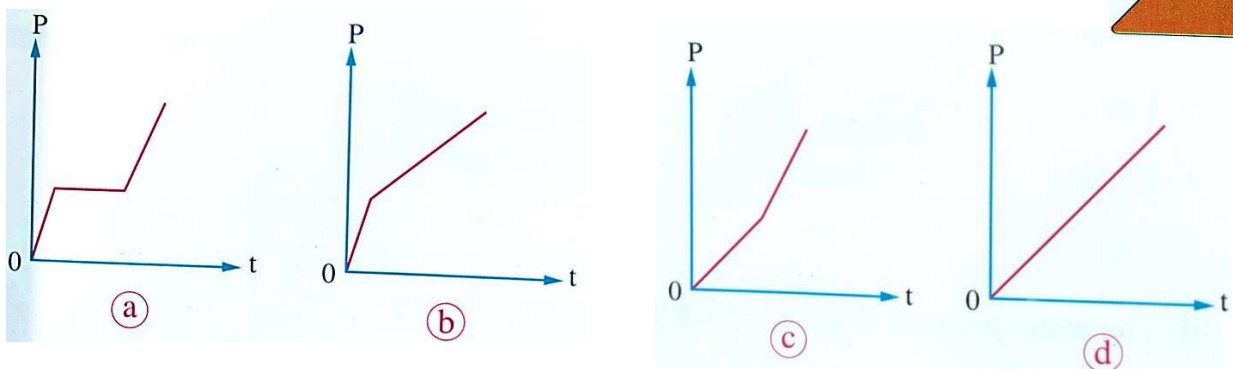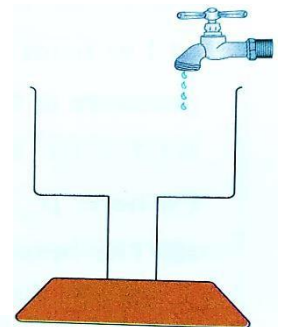
Applications on the pressure at a point inside the liquid

1) Connected vessels   2) U-shaped tube
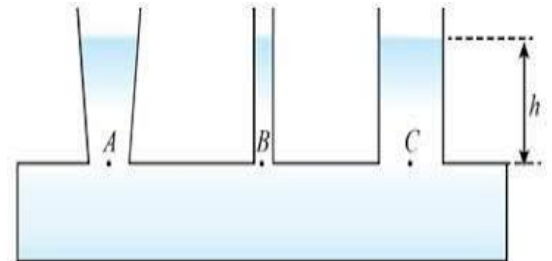
3) Mercuric barometer   4) Manometer

1-Connected vessels:

- Structure: Container consists of many vessels of different geometrical shapes connected at its base.

- **Idea of work:**

Pressure at all points in the same horizontal plane in a liquid is the same.

- SO $P_A = P_B = P_C$

2) U-shaped tube:

- **Idea of work:** Pressure at all points in the same horizontal plane in a liquid is the same.

-**Uses:**

1-Comparing the density of the two liquids.

2-Determining the density of a liquid by knowing the density of another liquid.

3-Determining the relative density of a liquid that doesn't mix with water (immiscible liquid).

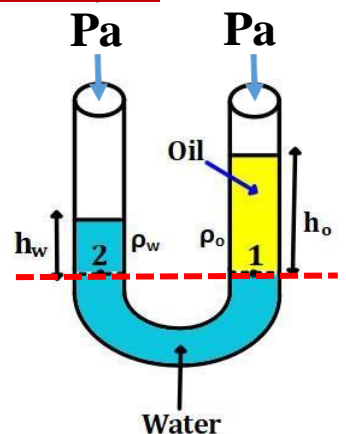### ★Determination of the density of oil by knowing the density of water using U-shaped tube:

∵points (1) and (2) at the same horizontal plane

∴ $(P_1) = (P_2)$

∴ $P_a + \rho_o g h_o = P_a + \rho_w g h_w$

∴ $\rho_o h_o = \rho_w h_w$

$$\therefore \frac{\rho_o}{\rho_w} = \frac{h_w}{h_o}$$

- $(\frac{\rho_o}{\rho_w})$ is the relative density of oil.

★**Notes:**

**1)The height of the liquid in the tube is inversely proportional to its density (h α $\frac{1}{\rho}$).**

2) Radius of the tube doesn't affect the height of the liquid in the sides of the tube.
So, we can apply the relation ($\rho_1 h_1 = \rho_2 h_2$) in U-shaped tube with different diameter.

3) In case of miscible liquids, they can be separated by a third liquid that is immiscible with each of them like mercury which can separate water and alcohol.

$\rho_1 h_1 = \rho_2 h_2 + \rho_3 h_3$
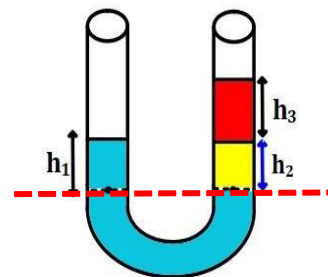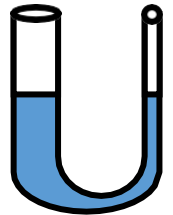
4) When pouring an amount of liquid X in a U-shaped tube whose arms have cross-sectional areas A₁ ,A₂ , then an amount of another liquid Y is added in one of its arms, the surface of liquid X in this arm gets lowered down a distance h₁ and it rises in the other arm a distance h₂ and at all times:
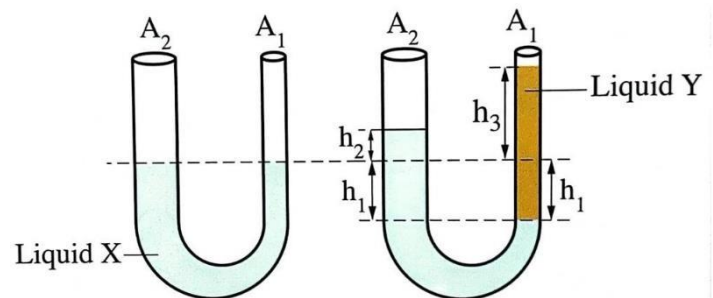
(1) The volume of the liquid which is displaced downward (A₁h₁) = The volume of the liquid which is displaced upward (A₂h₂)

(2) The height of liquid X that is displaced upward in the tube above the level of the interface between the two liquids hₓ = h₁ + h₂

(3) The height of liquid Y above the level of the interface: h_y = h₁ + h₃

(4) At the level of the interface: ρₓhₓ = ρ_y h_y

Class Sheet

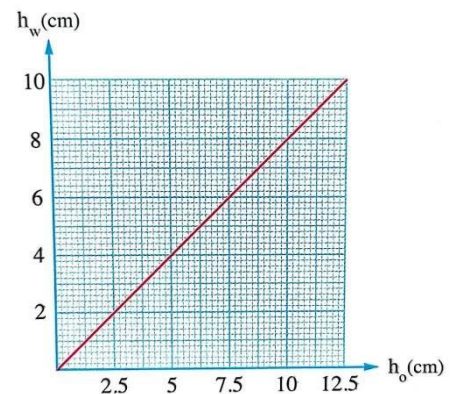**1- A U-shaped tube of uniform cross-sectional area is partially filled with water of density 1000 kg/m³, then oil of density 800 kg/m³ is poured in one of its arms until the height of oil column becomes 5 cm above the separating surface at equilibrium, then the height of water above the level of the separating surface is…………**

a) 2 cm

b) 4 cm

c) 5 cm

d) 8 cm

2- A U-shaped tube was containing an amount of water, then oil is poured gradually in one of its arms. If the opposite graph shows the relation between the height of oil (h_o) in one arm and the height of water in the other arm (h_w) above the level of the boundary surface between the two liquids, then the relative density of oil equals………….

a) 0.6

b) 0.7

c) 0.8

d) 1.25

3- In the opposite figure, a U-shaped tube of uniform cross- section contains three immiscible liquids in a state of equilibrium. If the relative density of mercury is 13.6, then the relative density of oil is ………..

a) 0.6

b) 0.8

c) 0.85

d) 1.25
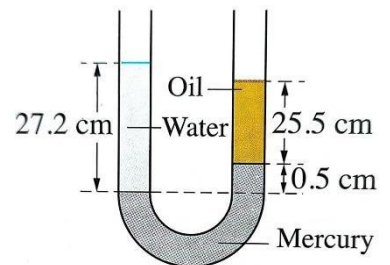
4- A U-shaped tube of uniform cross-section whose vertical height is 50 cm, is filled to half its height with water, then oil is poured in one of its arms until it has reached the top edge of that arm, if the density of oil is 750 kg/m³ and the density of water is 1000 kg/m³ then the height of oil will be..............

a) 15 cm

b) 30 cm

c) 35 cm

d) 40 cm

5- A U-shaped tube of height 60 cm is placed vertically. The cross-sectional area of one of its arms is double that of the other. It is filled until half its height with water, then oil of density 600 kg/m³ is poured in the narrow arm until it has reached the top e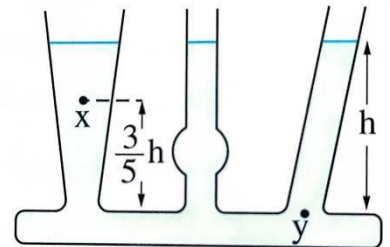dge of the tube, then the height of water above the level of the interface between the two liquids is ....($\rho_{water} = 1000$ Kg/m³)

a) 10 cm

b) 11.25 cm

c) 12.86 cm

d) 30 cm

1- The opposite figure shows a number of connected vessels that contain a liquid of density ρ. If the pressure of the liquid at point y is P, the pressure of the liquid at point x equals ....

a) $\frac{2}{3}$ p

b) $\frac{1}{3}$ p

c) $\frac{3}{5}$ p

d) $\frac{2}{5}$ p

2- A U-shaped tube contains an amount of water of density 10^3 kg/m³, then an amount of oil of density 875 kg/m³ is poured in one of its arms, if the height of oil column is 10 cm, the height of water column above the level of the interface with water which balances the oil's column is.....

a) 7.58 cm

b) 7.85 cm

c) 8.75 cm

d) 9.25 cm

3- The opposite figure shows two immiscible liquids x, y which are at an equilibrium state in a U-shaped tube, so the ratio between the densities of the two liquids $\left(\frac{\rho_x}{\rho_y}\right)$ is...........

a) $\frac{1}{2}$

b) $\frac{2}{5}$

c) $\frac{5}{2}$

d) $\frac{2}{1}$
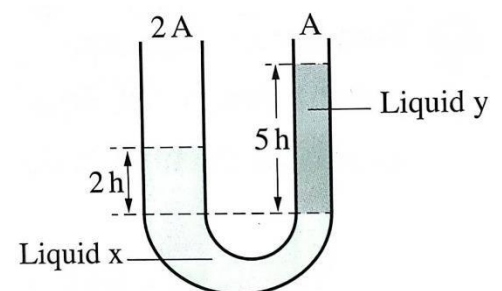
4- An oil of relative density 0.8 is poured in one of the arms of a U-shaped tube of uniform cross-sectional area that contains an amount of water, then the height difference between the levels of oil and water is…………… the height of water above the level of separating surface.

a) $\frac{1}{4}$ b) $\frac{1}{5}$

c) $\frac{1}{2}$ d) $\frac{2}{5}$

5- A U-shaped tube contains water of density 10^3 kg/m³, after pouring oil in one of its two branches the height difference between the water surfaces in the two branches becomes 19 cm, then if the oil density is 800 kg/m³, the height of oil equals………

a) 21.25 cm b) 21.75 cm

c) 22.5 cm d) 23.75 cm

6- In the opposite figure, an amount of water of density 1000 kg/m³ is poured in one of the arms of a U-shaped tube, then an amount of oil is added. If the liquids become in equilibrium, then the density of oil is………

a) 800 Kg/m³ b) 875 Kg/m³

a) 900 Kg/m³ b) 950 Kg/m³
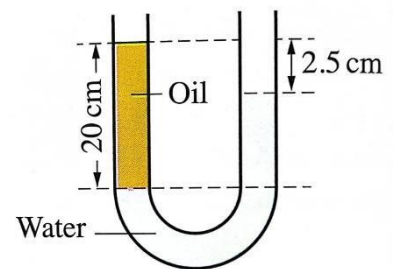
7- In the opposite figure, a U-shaped tube containing two liquids a, b, so the ratio between the densities of the liquids $(\frac{\rho_a}{\rho_b})$ is……………

a) $\frac{1}{2}$ b) $\frac{1}{4}$

c) $\frac{2}{1}$ d) $\frac{4}{1}$
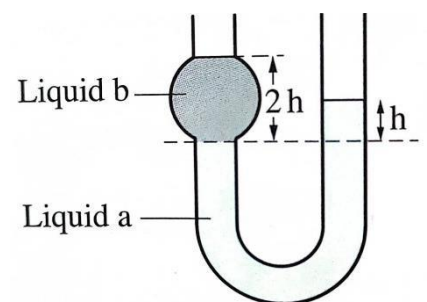
8- In the opposite figure, a U-shaped tube contains three immiscible liquids in equilibrium, so the height of mercury (h_{Hg}) above the level of interface between water and mercury is nearly…………

(Take: $\rho_o = 850$ Kg/m³, $\rho_w = 1000$ Kg/m³ , $\rho_{Hg} = 13600$ Kg/m³)

a) 4.15 cm b) 3.75 cm

c) 3.25 cm d) 2.35 cm

9- Two immiscible liquids x and y are put in a U-shaped tube. If the density of liquid x is 2 ρ and the density of liquid y is ρ, which of the following choices represents the positions of liquids in the tube at equilibrium?

10- In the opposite figure, a U-shaped tube contains two immiscible liquids in a state of equilibrium, then which of the following ratios for the pressure at points 1 , 2 , 3 , 4 is greater than one?

a) $\dfrac{P_1}{P_4}$

b) $\dfrac{P_2}{P_4}$

c) $\dfrac{P_1}{P_3}$

d) $\dfrac{P_3}{P_2}$

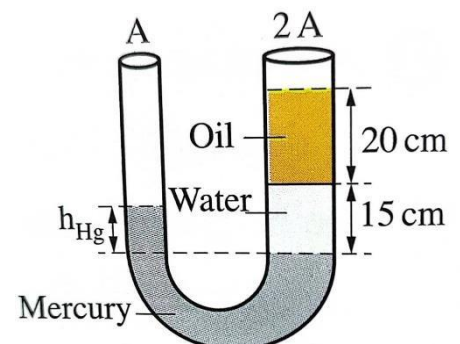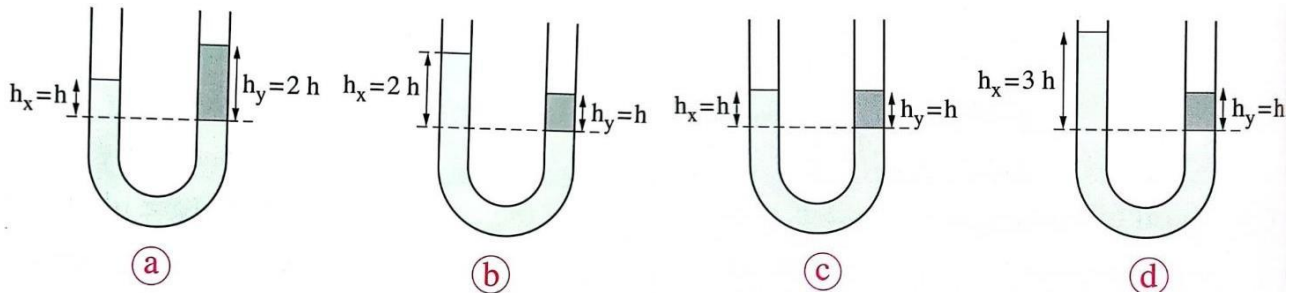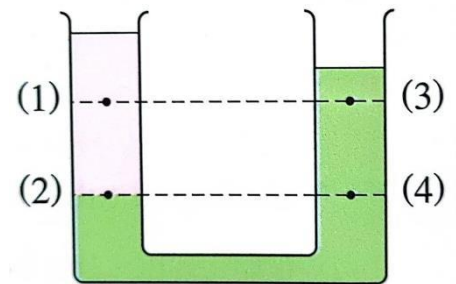**11- A U-shaped tube of uniform cross-section of height 30 cm is placed vertically, then gets filled with water up to its half. Oil is poured in one of its arms till the edge, then if the oil density is 800 kg/m³ and water density is 1000 kg/m³, the water height above the separating surface is…………**

a) 10 cm   b) 15 cm

c) 20 cm   d) 25 cm

12- The opposite figure shows a U-shaped tube of uniform cross-sectional area of 1cm² When two equal volumes of water and mercury, each of value 20 cm³ are poured into the U-shaped tube, they become in equilibrium state as shown in the figure, then the height difference (x) between the levels of the two liquids in the arms of the tube equals……………

$(\rho_w = 1000\ \text{Kg/m}^3 , \rho_{Hg} = 13600\ \text{Kg/m}^3)$

a) 21.47 cm   b) 20 cm

c) 19.14 cm   d) 18.53 cm
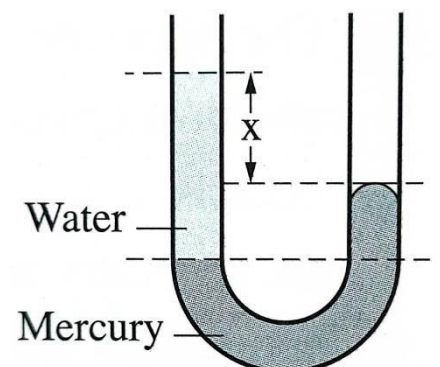
13- In the opposite figure, a vertically oriented U-shaped tube contains two immiscible liquids in a state of equilibrium, then the ratio between the densities of the two liquids $\left(\dfrac{\rho_x}{\rho_y}\right)$ equals......

a) $\dfrac{2}{1}$ b) $\dfrac{3}{1}$

c) $\dfrac{4}{1}$ d) $\dfrac{5}{1}$
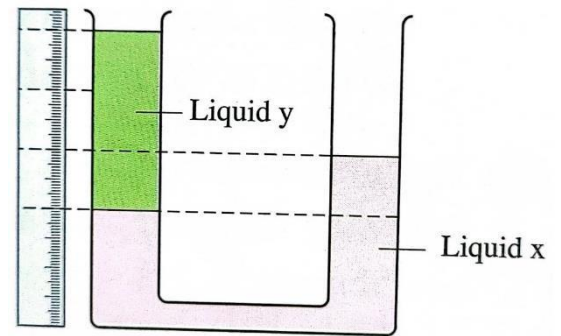
Liquid y

Liquid x

14- The opposite figure shows a U-shaped tube containing three immiscible liquids at equilibrium, then the height of water column equals..........   (Take: $\rho_{kerosene} = 800$ Kg/m³, $\rho_w = 1000$ Kg/m³ , $\rho_{Hg} = 13600$ Kg/m³)

a) 17.2 cm   b) 24 cm

c) 32 cm   d) 36 cm
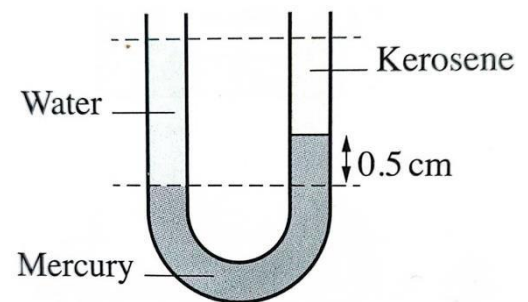
Kerosene

Water

Mercury

0.5 cm

15- The opposite figure shows a U-shaped tube containing two immiscible liquids at equilibrium, then the ratio between the masses of the two liqui ds $\left(\dfrac{m_1}{m_2}\right)$ above the separating surface equals...............

a) $\dfrac{3}{2}$ b) $\dfrac{2}{1}$

c) $\dfrac{2}{3}$ d) $\dfrac{4}{3}$

A   2 A

Liquid 2

1.5 h

Liquid 1

h
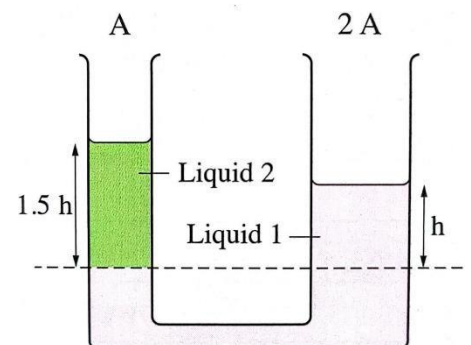
16- The opposite figure shows a U-shaped tube containing three immiscible liquids a, b, c at equilibrium, then the correct order for their densities is...........

a) $\rho_a > \rho_b > \rho_c$ b) $\rho_a < \rho_b > \rho_c$

c) $\rho_c > \rho_a > \rho_b$ d) $\rho_c > \rho_b > \rho_a$

Liquid b

Liquid a

Liquid c

17- The opposite figure shows a U-shaped tube containing two immiscible liquids A, B of densities 600 kg/m³ and ρ respectively, then the value of ρ is....................
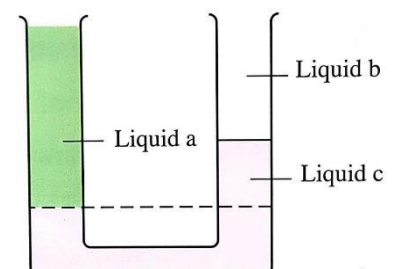
a) 400 kg/m³

b) 800 kg/m³

c) 900 kg/m³

d) 1200 kg/m³

h

h — Liquid A — Liquid B

h

h

h

18- A U-shaped tube containing three immiscible liquids (x, y, z) at equilibrium where their levels are as shown in the opposite figure. If the density of liquid y is double that of x and pressure of liquid x equals P. then the pressure due to the three liquids at point m equals..................

a) 3 P

b) 6 P

c) 9 P

d) 12 P

h — Liquid x

h — Liquid y — $\frac{1}{2}h$

h — Liquid z

m

19- A U-shaped tube of uniform cross-section of area 5 cm² contains an amount of mercury. An amount of glycerin is added in one of its arms, so the height of glycerin column above the interface with mercury becomes 10 cm, so the mass of water which is required to be poured in the other arm to make the surfaces of mercury in both arms at the same level equals...............

(Where: water density = 1000 kg/m³, glycerin density = 1260kg kg/m³, and mercury density = 13600 kg/m³)

a) 0.063 kg

b) 0.63 kg

c) 0.087 kg

d) 0.163 kg

3- Mercuric barometer:

*Structure: A glass tube of length (1m) is completely filled with mercury then turned upside down in a tank of mercury.

*Its idea: Pressure at all points in the same horizontal plane in a liquid is the same.

Points (A) and (B) are in the same plane.

∴ $P_A = P_B$,Where

P_A = Atmospheric pressure (Pa)

P_B = The pressure due to the weight of the mercury column, its height = 760 mm.
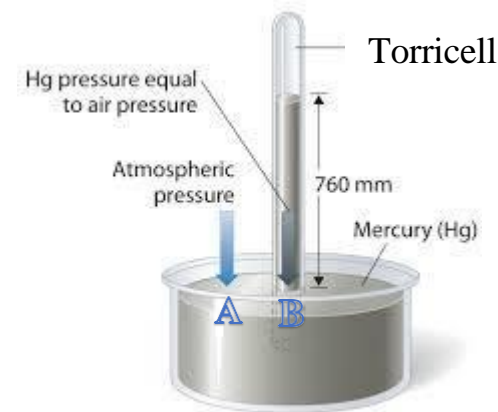
Torricelli Vacuum

The space above the mercury inside the tube of the mercuric barometer that is evacuated except a few of mercury vapor.

The atmospheric Pressure:

It is the weight of air column whose base is the unit area and its height extends from the sea level to the top of the atmosphere. **(OR)**

It is the air pressure at sea level which is equivalent to the pressure due to weight of mercury column of height 0.76 m and of base 1 m^2 at 0 ºC.

★**G.R: 1) Mercury is used as a barometric substance.**

Because the density of mercury is high so its height become suitable to the length of the barometer tube where ($h \propto \dfrac{1}{\rho}$).

2) <u>Water can't be used instead of mercury in the barometer.</u>

Because the density of water is much less than that of mercury. So, if water is used then the length of the tube of the barometer must be greater than 10 meters.

3) <u>Mercury height in the barometer is not affected by the cross-sectional area of the barometric tube.</u>

Because according to the relation (P= ρ g h) height of mercury in the barometric tube depends on the mercury density only.

★<u>Factors affect the reading of the mercuric barometer:</u>

    1- Temperature of atmosphere.
    2- Height from the sea level.

★<u>W.D: Torricelli vacuum disappear in the barometric tube?</u>

When the vertical height of the tube from the mercury level is less than or equal 76 cm.

★<u>Uses of the mercuric barometer:</u>

    1- Determination of the atmospheric pressure.
    2- Determination of the height of a mountain or a building.
    3- Determination of the density of air.

$$\rho_{Hg} (h_1 - h_2) = \rho_{air}\ h_{mountain}$$

<u>Where:</u>

(h_1) height of mercury at sea level.

(h_2) height of mercury above the mountain.

★<u>Factors affecting the atmospheric pressure:</u>

1-Height of the point from the sea level.

2-Temperature

3-Acceleration due to gravity

4- The density of atmospheric air

★Measuring units of atmospheric pressure:

> **atm , N/m^2 , Pascal , Bar , Cm Hg , Torr**

The Values of the atmospheric pressure by different units

1 atm = 1.013 x 10^5 N/m^2 = 1.013 x 10^5 Pascal

$) \therefore$ 1 N/m^2 = 1 Pascal)

1 atm = 1.013 Bar   ($\therefore$ 1 bar = 10^5 N/m^2)

1 atm = 76 Cm Hg

76 Cm Hg = 760 mmHg = 0.76 m Hg =760 Torr   ($\therefore$ 1 mm Hg = 1 Torr)

★ To convert the atmospheric pressure from unit to another:

Pressure in the required unit = $\dfrac{\text{The quantity to be converted} \times \text{Atmospheric pressure in the required unit}}{\text{Atmospheric pressure in the original unit}}$

★ W.H:

1) If the barometer is transferred to the top of a mountain concerning to height of mercury column.

The height of mercury decreases due to the decrease of the atmospheric pressure as we go higher.

2) If the cross-sectional area of the barometric tube increases concerning to the height of mercury column.

The height of mercury doesn't change because it doesn't depend on the cross-sectional area of the tube.

Class Sheet

1- If the pressure of an enclosed gas is 152 cm Hg, then its pressure in bars equals…………

a) 1.013

b) 2.026

c) 3.039

d) 4.052

2- If the pressure at a point inside a liquid is 1000 torr, then this pressure in pascal equals……

a) 1.013×10^5

b) 1.13×10^5

c) 1.33×10^5

d) 1.93×10^5

3- If oil is used instead of mercury in the barometer, then the height of oil column in the barometer tube at the standard atmospheric pressure is .... (Where: the density of oil = 800 kg/m³, the density of mercury = 13600 kg/m³)

a) 12.92 m

b) 13.78 m

c) 18 m

d) 21.6 m

4- The opposite figure shows a mercury barometer measuring atmospheric pressure. If the tube of the barometer is inclined to the horizontal by 30° then the measured atmospheric pressure equals (Where g = 9.8 m/s² , ρ_{Hg} =13600 kg/m³)

a) 9.6×10^4 N/m^2

b) 1.013×10^5 N/m^2

c) 1.92×10^5 N/m^2

d) 3.86×10^5 N/m^2
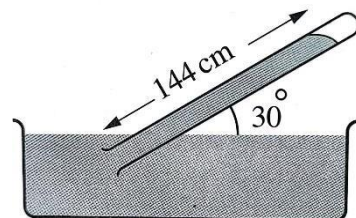
5- If the reading of a mercury barometer at sea level is 76 cm Hg and its reading at the top of a mountain is 60 cm Hg, then given that the average density of air is 1.25 kg/m³ and that of mercury is 13600 kg/m³ the height of the mountain above sea level equals...........

a) 1741 m

b) 1856 m

c) 3216 m

d) 6528 m

6- From the opposite figure, the pressure of the gas trapped by the water column equals………….

(Where g = 9.8 m/s² , ρ_{Hg} =13600 kg/m³ , ρ_w = 1000 kg/m³)

a) 23.7×10^3 N/m²   b) 46.92×10^3 N/m²

c) 93.84×10^3 N/m²   d) 187.68×10^3 N/m²

Gas — 76 cm — Water
Vacuum — 76 cm — Mercury
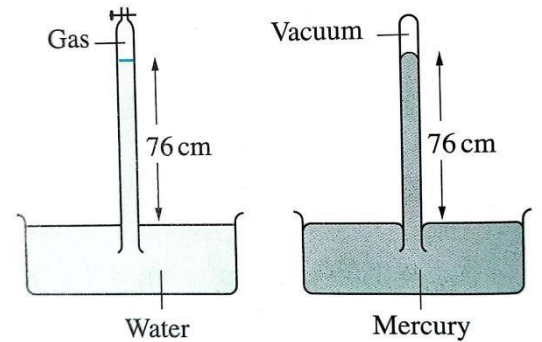
7- Consider that a mercury barometer is placed in a well sealed chamber that is getting evacuated partially from air gradually using a vacuum pump, then the Torricellian space inside the barometer tube…………

a) increases   b) decreases but does not vanish

c) does not change   d) decreases till vanishes

Vacuum pump
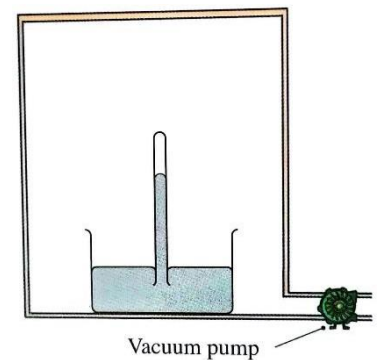
<mark>**Homework**</mark>

1- Four barometer tubes have been filled with mercury. then upturned in an open mercury filled basin as shown in the figure, in which of these tubes the height of mercury column is not representing the atmospheric pressure?

a) (1)   b) (2)

c) (3)   d) (4)

(1) (2) (3) (4)
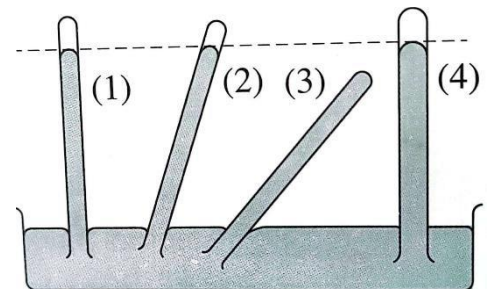
2- The mercury height inside the tube of the mercury barometer decreases when…………

a) the amount of mercury in the basin increases

b) the cross-sectional area of the tube increases.

c) the barometer is transferred to the top of a high mountain

d) using a longer tube

3- In the following figure, four mercury barometers which are different in the cross-sectional area of their tubes are used to measure the atmospheric pressure in four different places at the same temperature. In which of them the barometer reads the least value of atmospheric pressure?

0.02 cm² 76.1 cm (a)

0.01 cm² 76 cm (b)

0.04 cm² 76 cm (c)

0.05 cm² 75 cm (d)

4- The presence of a small amount of air in the space above the mercury in the barometer tube leads to the decrease of mercury level inside the tube, because air molecules…………..

a) cool down the mercury so it contracts
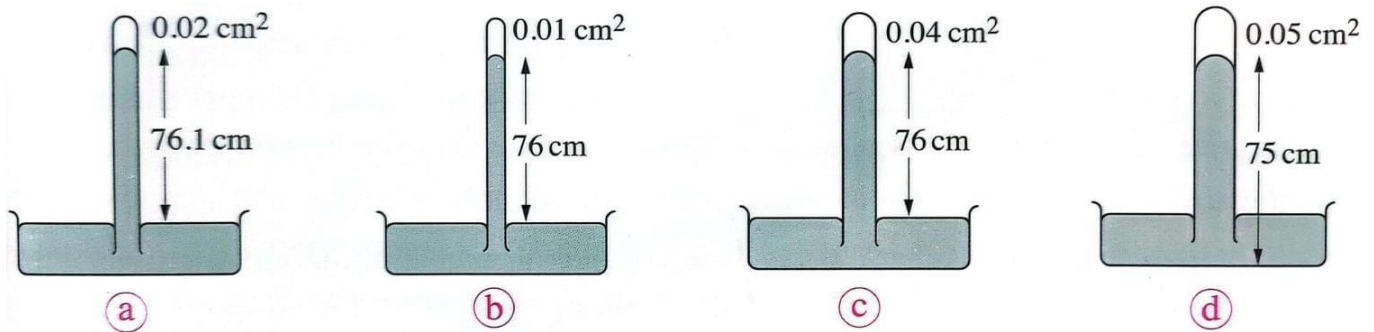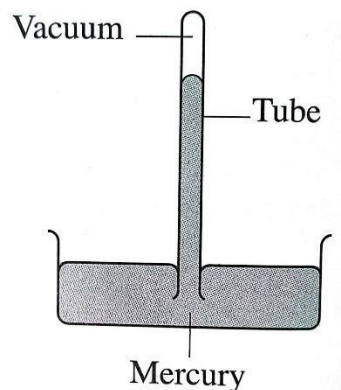
b) heat up the mercury so it expands

c) prevent the evaporation of mercury in the tube

d) increase the pressure on the surface of mercury in the tube

5- The opposite figure shows the reading of a mercury barometer at the top of a mountain. If the barometer is transferred to the bottom of the mountain, then the level of the mercury surface…….

Vacuum — Tube — Mercury

	In the barometer basin	In the barometer tube
(a)	increases	increases
(b)	decreases	decreases
(c)	increases	decreases
(d)	decreases	increases

6- The opposite figure shows three mercury barometers placed in the same room in the same horizontal level, then the relation between the lengths of the mercury columns from the surface of mercury in the basin to its surface inside the tube in each case is………….

A ℓ_1 2 A ℓ_2 A ℓ_3

a) $\ell_1 < \ell_2 < \ell_3$ b) $\ell_1 < \ell_2 = \ell_3$
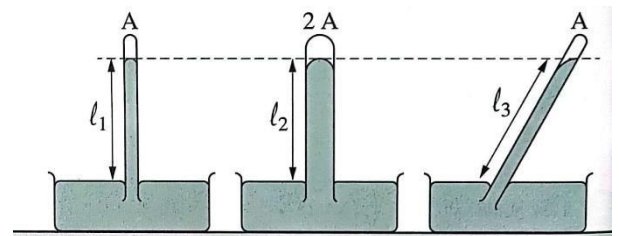
c) $\ell_1 < \ell_2 > \ell_3$ d) $\ell_1 = \ell_2 < \ell_3$

7- Two adjacent mercury barometers (x, y) have cross-sectional areas 1 cm² , 2 cm² respectively, so the ratio between the height of mercury column in the tube of barometer x to the height of mercury column in the tube of barometer y ($\frac{h_x}{h_y}$) is………..

a) $\frac{1}{1}$ b) $\frac{1}{4}$ c) $\frac{1}{2}$ d) $\frac{4}{1}$

8- The approximate mass of an air column that extends from the sea level to the end of the atmosphere with cross-sectional area 1 cm² equals……….. (Given that: the atmospheric pressure = 10^5 pascal, acceleration due to gravity = 10 m/s²)

a) 0.01 kg   b) 0.1 kg

c) 1 kg   d) 2 kg

9- If the reading of a mercury barometer is decreased due to a storm by 20 mm from the standard atmospheric pressure, then the value of the atmospheric pressure in pascal in this case equals… ………(Given that: ρ_{Hg} = 13600 kg/m³, Pa = 1.013 × 10⁵ N/m² ,g = 9.8 m/s²)

a) 24.65 × 10³ pascal   b) 49.3 × 10³ pascal

a) 9.86 × 10⁴ pascal   a) 19.72 × 10⁴ pascal

10- The reading of a mercury barometer at the highest point of a building of height 200 m was 74 cm Hg, then the reading of the barometer at the Earth's surface equals………….

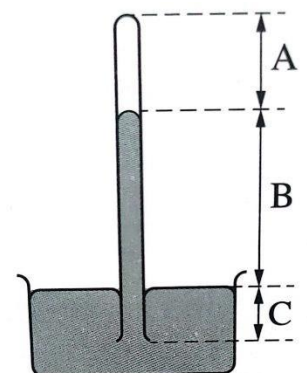**(Given that: average density of air = 1.3 kg/m³ , ρ_{Hg} =13600 kg/m³)**

a) 74.8 cm Hg   b) 75.9 cm Hg

c) 76.8 cm Hg   d) 76.5 cm Hg

11- The opposite figure shows a mercury barometer:

(i) Which of the shown distances decreases by increasing the atmospheric pressure?

a) A only   b) B, C

c) C only   d) A.C

(ii) If air is leaked to the upper part of the tube then the height (B) of mercury column inside the tube…………

a) decreases   b) vanishes

c) increases   d) remains constant

12- A mercury barometer, whose tube is vertically oriented with a height of 1 m above the mercury surface in the basin, shows a reading of 76 cm Hg at the bottom of a mountain and when it gets transferred to the top of the mountain, its reading has changed by 4 cm Hg. so the ratio of Torricellian space length at the bottom of the mountain to its length at the top is…………

a) $\frac{7}{6}$ b) $\frac{6}{7}$

c) $\frac{1}{1}$ d) $\frac{4}{1}$

13- The reading of a mercury barometer was 0.71 m Hg at the sea level and 0°C, so the probable reason for this reading is………..

a) the presence of a space of length 3 cm above mercury

b) the spilling of some mercury outside of the basin

c) the leaking of an air bubble to the inside of the tube

d) the atmospheric pressure at these conditions is 0.71 m Hg
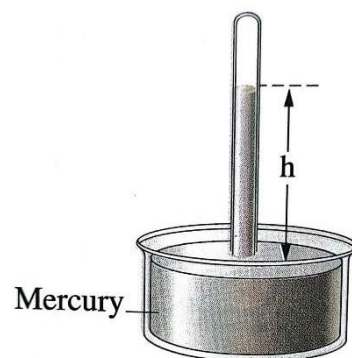
14- Two mercury barometers are identical, however, one of them has a vacuum space above the mercury level inside its tube while the other has air with the heights that are as shown in the figure, then the pressure of air (X) equals…………..

a) 40 mm Hg   b) 50 mm Hg

c) 150 mm Hg   d) 180 mm Hg
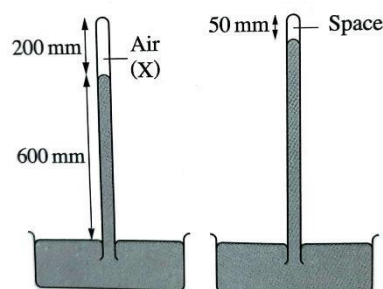
4) Manometer:

*Structure:

U-Shaped tube containing proper amount of liquid of known density. One of its ends is connected to the gas reservoir and the other end exposed to air.
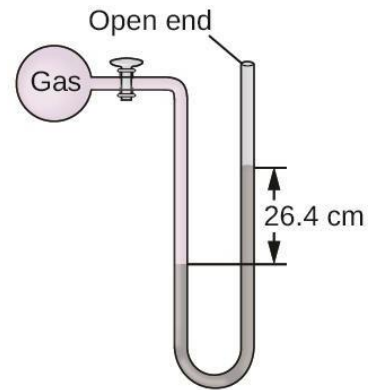
*Types:

1) Aqueous manometer   (The liquid used is water).

Used to **measure small pressure of enclosed gas**

2) Mercuric manometer   (The liquid used is mercury).

Used to **measure high pressure of enclosed gas**

*Idea of working:
Pressure at all points in the same horizontal plane in a liquid is the same.
*Uses:
1) Measuring the pressure of enclosed gas
2) Measuring the difference between the pressure of enclosed gas and the atmospheric pressure.
★ **G.R:**
1) The aqueous manometer is preferred to the mercuric one to measure small pressure difference.

Because the density of water is small compared to that of mercury so the difference in water levels in the two branches become more clear and easy to be measured and error decreased.

2) It is preferable to use the mercuric manometer for measuring high pressure difference.
Because the mercury has high density, so mercury neither rush out the tube nor into the gas reservoir.

-How manometer is used ?
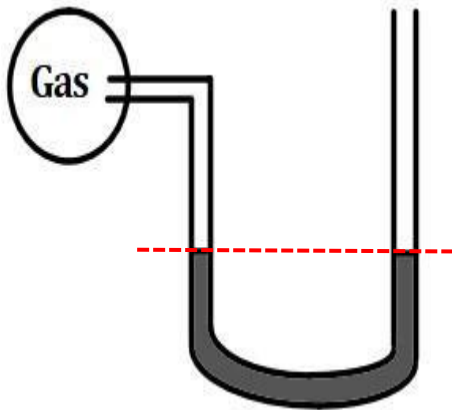
-In this case:
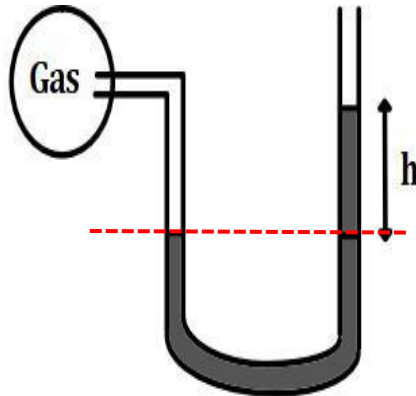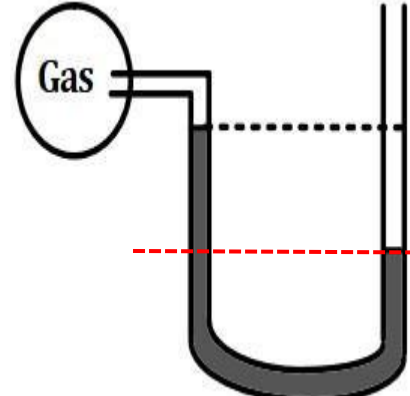
Pa = P $_{gas}$	P $_{gas}$ > Pa	P $_{gas}$ < Pa
ΔP= P $_{gas}$ – Pa = zero	P $_{gas}$ = Pa + ρ g h	P $_{gas}$ = Pa – ρ g h
ΔP= zero	ΔP = P $_{gas}$ – Pa	ΔP = P $_{gas}$ – Pa
	ΔP = ρ g h (N/m²)	ΔP = – ρ g h (N/m²)

If the liquid used is mercury then:

ΔP= zero	P $_{gas}$ = Pa + h	P $_{gas}$ = Pa – h
	ΔP = +h (Cm Hg)	ΔP = – h (Cm Hg)

Class Sheet

1- If the mercury level in the open arm of a manometer is lower than its level in the arm connected to a reservoir by 20 cm, so given that the atmospheric pressure is 76 cm Hg then the pressure of the gas inside the reservoir in both of the units of cm Hg and bar respectively are……

a) 56 cm Hg , 0.75 bar   b) 56 cm Hg , 0.84 bar

c) 61 cm Hg , 0.75 bar   d) 61 cm Hg, 0.84 bar

2- A mercury manometer was used to measure the pressure of a gas reservoir. The mercury level in the open arm was higher than in the arm connected to the reservoir by 36 cm, then the pressure of the enclosed gas in:

(Given that: the atmospheric pressure (Pa) = 1.013×10^5 N/m² = 0.76 m Hg)

(i) cm Hg equals………….

a) 116   b) 112

c) 106   d) 92

(ii) atm equals………….

a) 1.21   b) 1.39

c) 1.47   d) 1.53

(iii) N/n² equals ……………..

a) 1.23×10^5 b) 1.41×10^5

c) 1.49×10^5 d) 1.54×10^5

3- The opposite figure shows a manometer while being used to measure the pressure of a gas container, then the pressure of the enclosed gas inside the container equals………….

(Given that: ρ_{Hg} = 13600 kg/m³, ρ_{water} =1000 kg/m³, Pa = 1.013×10^5 N/m² ,g = 9.8 m/s²)

a) 1.41×10^5 N/m²   b) 1.03×10^5 N/m²

c) 1.12×10^5 N/m²   d) 2.06×10^5 N/m²
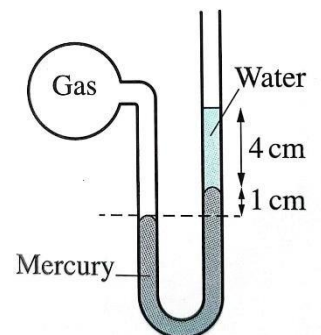
4- In the opposite figure, the pressure at point y is………….

(Given that: ρ_{Hg} = 13600 kg/m³, ρ_{water} =1000 kg/m³, Pa = 10^5 N/m² ,g = 10 m/s²)

a) 1.16×10^5 N/m²   b) 1.24×10^5 N/m²

c) 2.32×10^5 N/m²   d) 2.48×10^5 N/m²
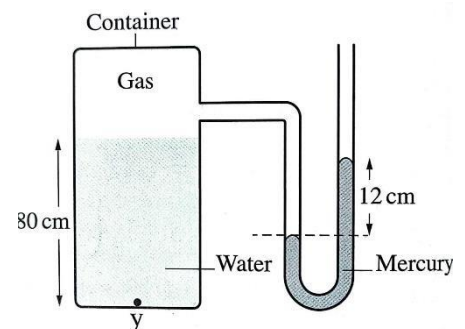
Homework

1- A mercury manometer was connected to a gas reservoir so that the surface of mercury in the open arm was lower than that in the arm connected to the reservoir by 15 cm, then the pressure of the enclosed gas in units of: (where: Pa = 76 cm Hg)

(i) torr equals…………

a) 570   b) 610

c) 650   d) 760

(ii) bar equals……………

a) 0.75   b) 0.81

c) 0.86   d) 1.19

2- In the opposite figure, if the atmospheric pressure is 100 kPa, then the height (h) equals……… (Take ρ_{Hg} =13600 kg/m³ , g = 9.8 m/s²)

a) 0.25 m   b) 0.28 m

c) 0.375 m   d) 0.56 m
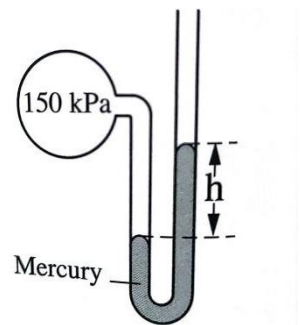
3- In the opposite figure, a water manometer is connected to a gas reservoir, then: (Given that: ρ_w = 1000 kg/m³, Pa = 1.013 × 10⁵ N/m² , g = 9.8 m/s²)

(i) The pressure of the gas equals……………

a) 9.5×10^4 N/m²   b) 9.9×10^4 N/m²

c) 100.32×10^3 N/m²   d) 102.28×10^3 N/m²
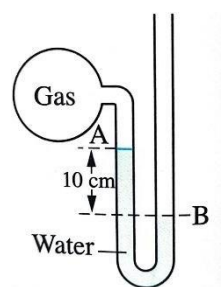
(ii) The pressure difference between points A, B equals……….

a) 490 N/m²   b) 980 N/m²

c) 1950 N/m²   d) 2300 N/m²

4- In the opposite figure, a gas container is connected to a water manometer, if the atmospheric pressure in that place was 75 cm Hg, then the enclosed gas pressure equals…………..

(Given that: $\rho_w = 1000$ kg/m³, $\rho_{Hg} = 13600$ kg/m³ , g = 9.8 m/s²)

a) 1.0129×10^5 N/m²   b) 1.0212×10^5 N/m²

c) 1.0254×10^5 N/m²   d) 1.0293×10^5 N/m²

Gas
C
13.6 cm
A - - - B
Water
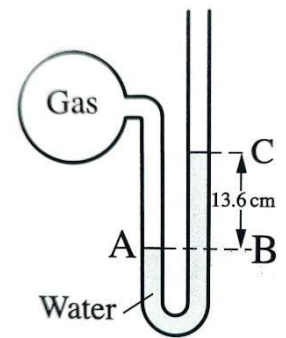
5- The opposite figure shows a gas reservoir connected to a water manometer, then:

(i) The pressure of the enclosed gas in the reservoir……………the atmospheric pressure.

a) less than   b) equals

c) greater than   d) answer is indeterminable

Air
Gas
8 cm
4 cm
Water
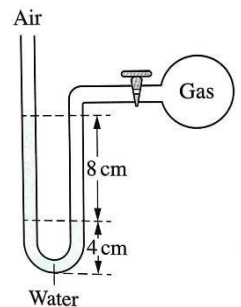
(ii) The difference between the pressure of the enclosed gas in the reservoir and the atmospheric pressure is equivalent to the pressure of water column of height…………..

a) 4 cm   b) 6 cm

c) 8 cm   d) 12 cm

6- The opposite figure shows a mercury manometer connected to a gas container which encloses carbon dioxide, so the pressure of the gas inside the container is……………….(Given that: Pa=76 cm Hg)

a) 72 torr   b) 80 torr

c) 720 torr   d) 800 torr

CO_2
4 cm
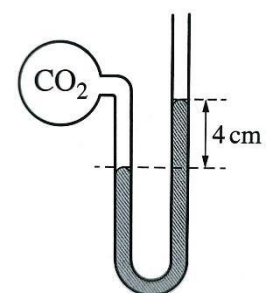
7- In the opposite figure, if the atmospheric pressure is 76 cm Hg. the pressure of the enclosed gas equals……….

a) 56 cm Hg   b) 68 cm Hg

c) 84 cm Hg   d) 96 cm Hg

Gas
Mercury
12 cm
20 cm
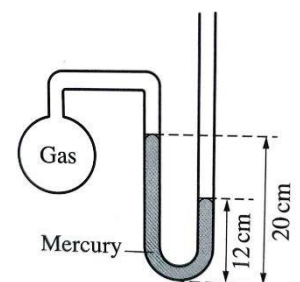
8- In the opposite figure, a manometer is connected to a small funnel whose opening is covered by a rubber sheet and submerged to a certain depth inside a liquid in a container, then the difference between the heights of mercury (h) in the two arms of the manometer increases when.............

a) increasing the cross-sectional area of the rubber sheet

b) increasing the cross-sectional area of the manometer tube

c) replacing the liquid in the container with another of higher density

d) replacing the liquid in the manometer with another of higher density

Enclosed gas

Liquid

Rubber sheet   Mercury

h
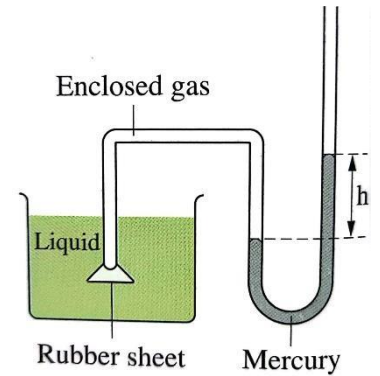
9- The opposite figure shows a water manometer while being used to measure the gas pressure inside a container, so the pressure of the gas equals the pressure of a water column of length……….

(Where: Pa =75 cm Hg, the relative density of mercury= 13.6)

a) 10cm   b) 20 cm

c) 1030 cm   d) 1040 cm

Gas

10 cm

10 cm

Water
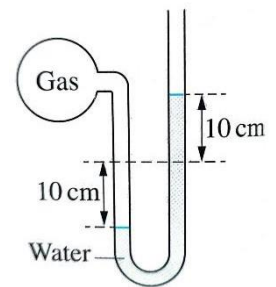
10- The opposite figure represents a mercury manometer containing an amount of oxygen gas above the mercury surface in its closed short arm. If the atmospheric pressure is equivalent to h cm Hg, then the pressure of the enclosed oxygen gas equals…………..

a) one time and a half as the atmospheric pressure

b) two times as the atmospheric pressure

c) two times and a half as the atmospheric pressure

d) three times as the atmospheric pressure

P_a

Mercury

Oxygen

h

h

3 h
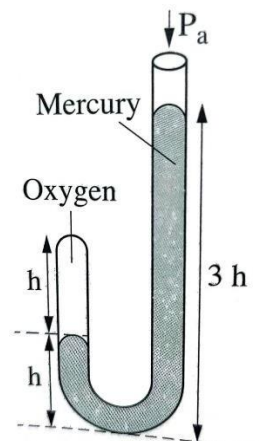
11- A mercury manometer is connected to a thermally isolated gas reservoir in which the pressure of the enclosed gas is higher than the atmospheric pressure at the Earth's surface If that manometer is transferred to the top of a mountain, then the height difference of the mercury levels in the arms of the manometer………….

a) vanishes   b) increases

c) decreases   d) doesn't change

12- A water manometer is used to measure the pressure of an enclosed gas in a container as shown in the figure. If mercury is used instead of water, then the height h……….

a) increases   b) decreases

c) remains unchanged   d) vanishes
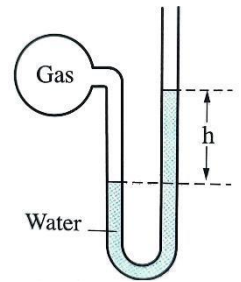
13- In the opposite figure, if the gas pressure in reservoir (x) equals 76 cm Hg, then the gas pressure in the reservoir (y) equals....................

a) 66 cm Hg   b) 76 cm Hg

c) 96 cm Hg   d) 86 cm Hg
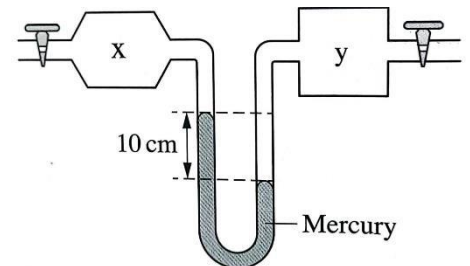
14- The opposite figure represents a mercury manometer of uniform cross-section connected with one arm to a container closed by a valve and enclosing a gas under a pressure of 60 cm Hg, given that the atmospheric pressure is 76 cm Hg, so when the valve gets opened, the level of mercury in the open arm of the manometer will…………….

a) decrease by 16 cm   b) increase by 8 cm

c) decrease by 8 cm   d) increase by 16 cm
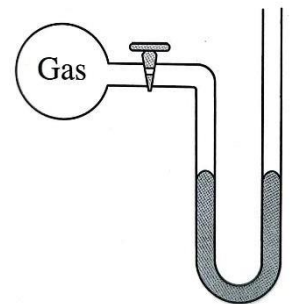
15- The opposite figure shows a mercury manometer containing a liquid of density ρ while each of its arms is connected to a reservoir containing different gas (x, y) then the pressure of gas x compared to that of gas y is…………….

a) higher by ρgh b) lower by ρgh

c) lower by $3 \rho gh$ d) higher by $3 \rho gh$
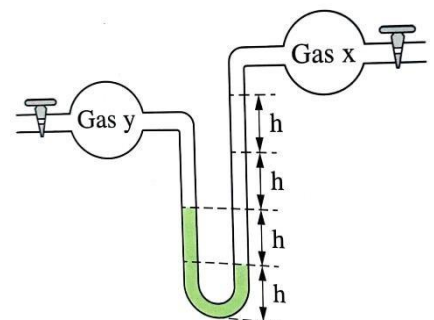
Pascal's Principle

Pascal's principal

When Pressure is applied on a liquid enclosed in a container, the pressure is transmitted in full to all parts of the liquid as well as to

★**G.R: Liquids obey Pascal's principle while gases don't obey it.**

➡ Because Liquids are incompressible while gases can be compressed.

★**Applications on Pascal's principle:**

1) The hydraulic press
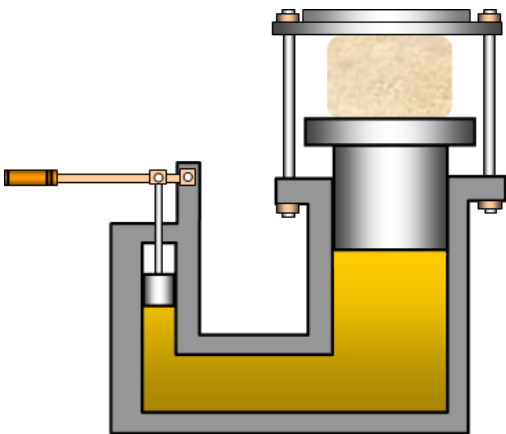
2) The hydraulic brakes of the car

3) The hydraulic lift

4) Chair of the dentist

★ The hydraulic press:

-Uses:

Lifting high loads using a small force.

-Idea of working:

Based on Pascal's principle.

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$$\frac{F_2}{F_1} = \frac{A_2}{A_1}$$

★When a force (f) is acted on the small piston, pressure (p) is produced and transfers completely to the lower surface of the big piston through the liquid where:

$$P = \frac{f}{a} = \frac{F}{-}$$

★ If the force (f) moved the small piston a distance (y_1) the big piston affected by a force (F) that moved it a distance (y_2)

∴The work done on the small piston = The work done on the big piston.

∴ $fy_1 = Fy_2$

$$\therefore \frac{F}{f} = \frac{y_1}{y_2}$$

The mechanical advantage (η)

It is the ratio between the force produced at the big piston and the acting force at the small piston.

$$\eta = \frac{F}{f} = \frac{A}{a} = \frac{R^2}{r^2} = \frac{D^2}{d^2} = \frac{y_1}{y_2} = \frac{V_1}{V_2}$$

- R ➡ radius of big piston.　　– d ➡ diameter of small piston

- r ➡ radius of small piston.　- V_1 ➡ speed of small piston.

- D ➡ diameter of big piston.　– V_2 ➡ speed of big piston.
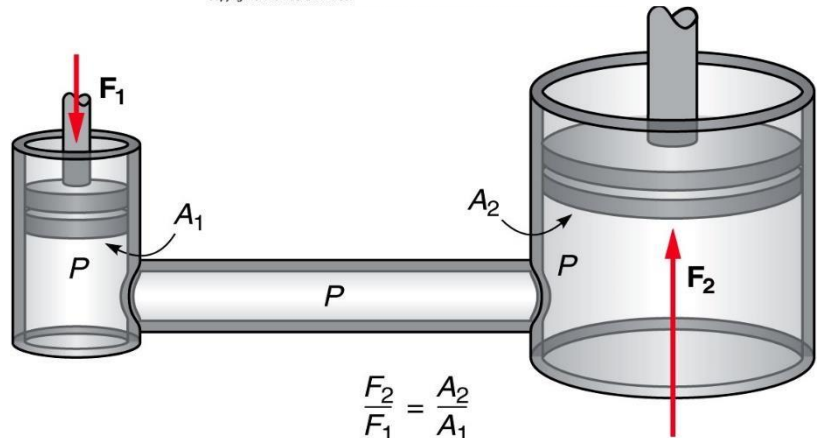
*Cases of hydraulic press
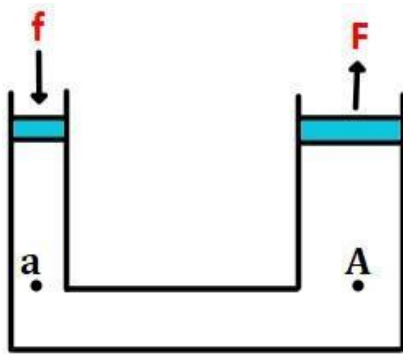
$$P = \frac{f}{a} = \frac{F}{A}$$
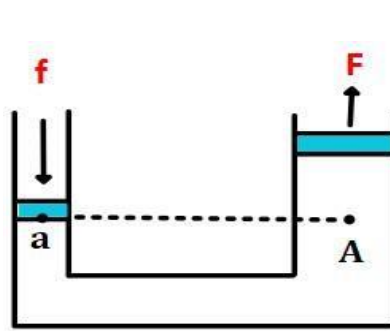
$$P = \frac{f}{a} = \frac{F}{A} + \rho\,g\,h$$
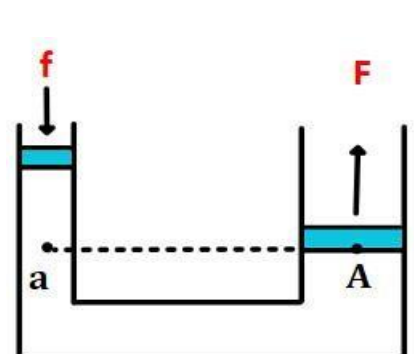
$$P = \frac{f}{a} + \rho\,g\,h = \frac{F}{A}$$

★ **Efficiency of the hydraulic**

Ratio between the work done at the big piston to the work done at the small piston.

Efficiency of hydraulic press = $\dfrac{Fy_2}{fy_1}$

★**G.R: Efficiency of hydraulic press doesn't reach 100%.**

➡ **Because of:**

1) Friction between the piston and the walls of the container

2) Gas bubbles in the liquid where work is consumed to reduce the volume of the bubbles.

★ **W.M: The mechanical advantage of a hydraulic press at equilibrium = 400.**

➡ The ratio between the force produced at the big piston to that acting at the small piston = 400.

Class Sheet

1- The cross-sectional area of the small piston of a hydraulic press is 10 cm^2 while the cross-sectional area of its big piston is 800 cm^2, so if a force of 100 N is exerted on the small piston, then: (Take: g=10 m/s^2)

(i) The biggest mass that can be lifted by the big piston due to the effect of that force assuming the two pistons are at the same horizontal level is……………..

a) 200 Kg   b) 400 Kg

c) 600 Kg   d) 800 Kg

(ii) The distance moved by the small piston to move the big piston 1 cm equals…………….

a) 50 cm   b) 80 cm

c) 10 cm   d) 120 cm

2- The opposite figure shows a hydraulic press that contains an amount of oil of density 800 kg/m^3, the cross-sectional area of its small piston is 10 cm^2 and the cross-sectional area of its big piston is 100 cm^2, if a force of 180 N is applied on the small piston, then (Take: g= 9.8 m/s^2)

(i) The force that is produced at the big piston is..........

a) 6.5×10^3 N   b) 1.7×10^3 N

c) 1.8×10^3 N   d) 1.9×10^3 N

(ii) The mechanical advantage of the piston is..........

a) 5   b) 10

c) 15   d) 20
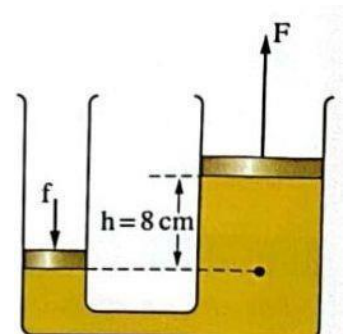
3- A hydraulic lift has two pistons whose radii are 4 cm, 60 cm. If an additional pressure of 8.48 ×10^4 N/m^2 affects the small piston, then the biggest mass that can be lifted by the big piston so that the two pistons become at the same horizontal level, equals.........

a) 4.797×10^3 Kg   b) 9.595×10^3 Kg

c) 47.97×10^3 Kg   d) 95.95×10^3 Kg

Homework

1- On which of the following materials Pascal's rule is applicable if the material fills a closed system?

a) Mercury   b) Sand   c) Iron filings   d) Hydrogen

2- The hydraulic presses that work according to Pascal's principal are used for amplifying the…….

a) pressure   b) work done   c) force   d) velocity

3- In the ideal hydraulic press, if the ratio between the radii of the two pistons is $\frac{8}{3}$, the ratio between the work done due to the motion of the big piston to that of the small piston is……

a) $\frac{3}{8}$ b) 1

c) $\frac{8}{3}$ d) $\frac{64}{9}$

4- In the hydraulic press, the ratio between the force produced at the big piston to that exerted on the small piston when the two pistons balance in one horizontal level is…………

a) greater than one   b) less than one   c) equal to one   d) indeterminable

5- When exerting a force on the small piston of a balanced hydraulic press, the ratio between the displacement of the small piston to that of the big piston in the hydraulic press will be…….

a) greater than one   b) less than one   c) equal to one   d) indeterminable

6- An ideal hydraulic press has two pistons of cross-sectional areas A, 2 A that are balanced as in the opposite figure. If the mass on its small piston is m_y and that on its big piston is m_x, then……

a) $m_x < m_y$ b) $m_x = 2m_y$

c) $m_x < 2m_y$ d) $m_x > 2m_y$
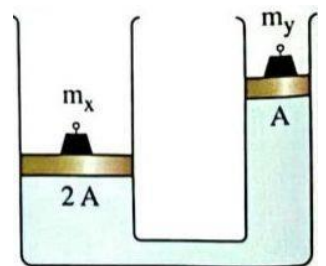
7- If the cross-sectional area of the big piston in a hydraulic press is double that of the small piston, so at the motion of the hydraulic press, the ratio between the volumes of the displaced liquid downward in the small piston cylinder to the displaced liquid upward in the big piston cylinder is………

a) $\frac{1}{2}$ b) $\frac{1}{1}$ c) $\frac{2}{1}$ d) $\frac{1}{4}$

8- In the opposite figure, the ratio of the pressure at the big piston to the pressure at the small piston is.........

a) $\frac{1}{2}$ b) $\frac{1}{1}$

c) $\frac{2}{1}$ d) indeterminable
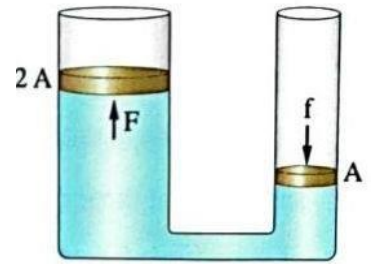
9- Which of the following graphs represents the relation between the magnitude of the big piston displacement y_2 and that of the small piston y_1, in a hydraulic press when the two quantities are plotted in the same scale?

(a) (b) (c) (d)
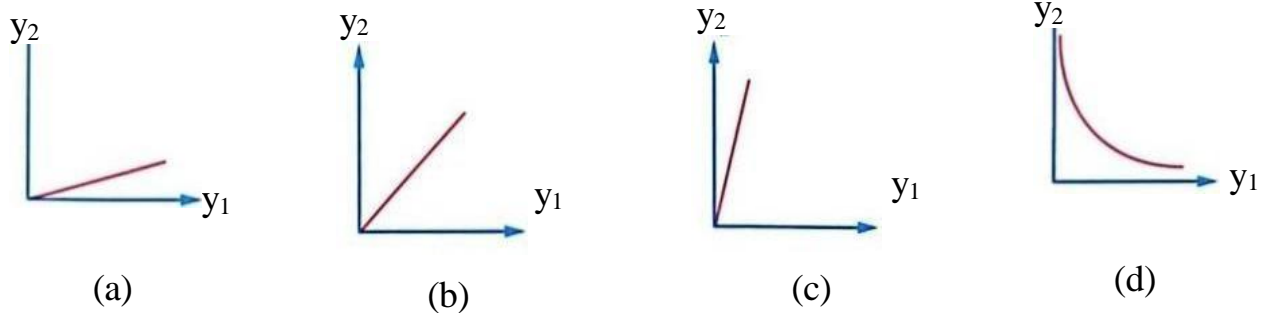
10- If the ratio between hydraulic press pistons' radii is $\frac{5}{1}$, the ratio between the pressure at the small piston to the pressure at the big piston, when they are balanced in the same horizontal level is..........

a) $\frac{1}{5}$ b) $\frac{5}{1}$

c) $\frac{1}{1}$ d) $\frac{25}{1}$

11- If the ratio between the radii of the two pistons of a hydraulic press is $\frac{5}{2}$, so the mechanical advantage of the press equals...........

a) $\frac{5}{2}$ b) $\frac{25}{4}$

c) $\frac{2}{5}$ d) $\frac{4}{25}$

12- If the mechanical advantage of a hydraulic press equals 250 and the cross-sectional area of the small piston is 2.5 cm², the radius of the big piston equals..........

a) 14.1 cm b) 100 cm

c) 198.81 cm d) 625 cm

13- A hydraulic press contains a liquid of density ρ, if its pistons that have cross-sectional areas of A and 3 A are balanced as in the figure, then the value of mass m on the big piston is calculated from the relation ………..

a) $m = \rho hA$

b) $m = 2\ \rho hA$

c) $m = 3\ \rho hA$

d) $m = 4\ \rho hA$
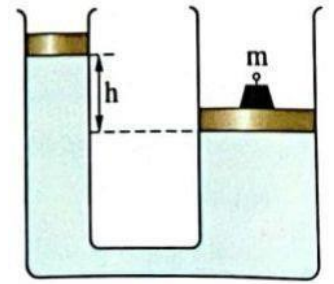
14- The opposite figure shows a completely water filled container in a state of equilibrium by means of three identical pistons, each of area A, that are placed at three openings. If additional force of magnitude F acted on each piston at the same moment, then the value of the pressure increase inside the liquid at the center of the container due to the additional force is equivalent to…………..

a) $\frac{F}{A}$

b) $\frac{2F}{A}$

c) $\frac{3F}{A}$

d) Zero
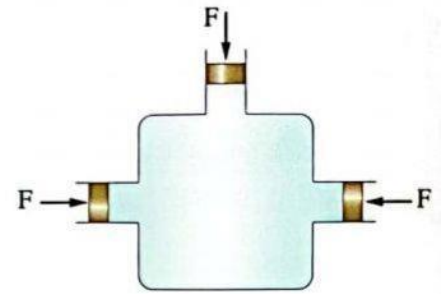
15- A hydraulic press has a small piston of cross-sectional area A carrying a load of mass m and a big piston of cross-sectional area 10 A carrying a load of mass M. When the two pistons are balanced in the same horizontal level and by ignoring their masses, then…………..

a) $M = m$

b) $M = 10\ m$

c) $M = 100\ m$

d) $M = 150\ m$
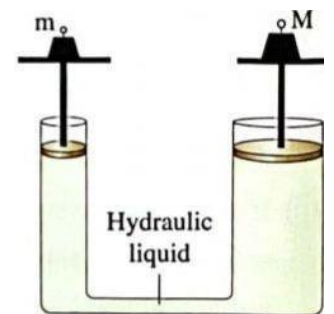
16- The ratio between the radii of the pistons of a hydraulic press was $\frac{5}{1}$. When its two pistons were balanced in the same horizontal level, the force acting on the small piston was 50 N, then:

(Given that: the acceleration due to gravity=10 m/s²)

(i) The mechanical advantage of the hydraulic press equals…………

a) 2.5

b) 5

c) 25

d) 20

(ii) The largest mass that can be lift on the big piston equals…………

a) 25 Kg

b) 75 Kg

c) 125 Kg

d) 250 Kg

(iii) The distance moved by the small piston if the big one is moved a distance of 1cm equals………

a) 2.5 cm　　　　　b) 15 cm

c) 25 cm　　　　　d) 50 cm

17- A hydraulic press has two pistons, the cross-sectional area of the big piston is 10 times that of the small piston. When the two pistons are balanced at the same horizontal level and a force of 100 N is applied on the small piston, the resulted force on the big piston equals …………..

a) 100 N　　　　　b) 1000 N

c) 2000 N　　　　　d) 10^4 N

18- A hydraulic press has two pistons of diameters 10 cm, 100 cm, if a force of 800 N is applied on the small piston, then the biggest mass that can be lifted upward by the big piston due to this force, so that the two pistons balance at the same horizontal level is……　　(g = 10 m/s^2)

a) 4000 Kg　　　　　b) 8000 Kg

c) 10 ton　　　　　d) 12 ton

19- A hydraulic lift in car service station has two pistons of radii 2 cm and 30 cm, so the minimum required force on the small piston to balance the two pistons in the same horizontal level when putting a car of mass 1500 kg on the big piston equals ………　　(g = 9.8 m/s^2)

a) 65.33 N　　　　　b) 130.66 N

c) 195.99 N　　　　　d) 980 N

20- An ideal hydraulic press has a big piston of radius 0.5 m. When a mass of 10 kg is placed above its small piston, it balances a mass of 5×10^3 kg on its big piston in the same horizontal level, so ………, ………

	The mechanical advantage of the press	The radius of the small piston
a	500	0.025 m
b	250	0.022 m
c	250	0.025 m
d	500	0.022 m

21- The hydraulic lift in a car service station uses compressed air to exert a force on its small piston that has diameter 2 cm, so if the diameter of its big piston is 32 cm, then the required air pressure to lift a car of mass 1800 kg equals……. (g = 10 m/s²)

a) 2.24×10^5 N/m²

b) 1.5×10^6 N/m²

c) 5.6×10^5 N/m²

d) 6.22×10^6 N/m²

22- The opposite figure shows a hydraulic press in equilibrium. If the cross-sectional areas of its pistons are 10 cm² and 4 cm², so the density of the hydraulic fluid is ············(g = 10 m/s²)

a) 720 Kg/m³

b) 800 Kg/m³

c) 980 Kg/m³

d) 1250 Kg/m³

f = 100 N
4 cm
F=250.32 N
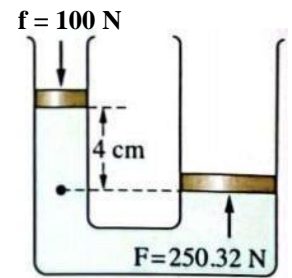
23- The opposite graph shows the relation between the produced force on the big piston (F) and the applied force on the small piston (f) for a hydraulic press when its two pistons are at equilibrium in the same horizontal level, so:

F(N)

(i) **The mechanical advantage for the press is …………..**

a) 50

b) 100

c) 150

d) 500
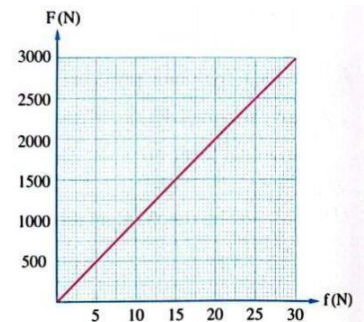
(ii) **If the radius of the small piston is 5 cm, the radius of the big piston is…………**

a) 25 cm

b) 37.5 cm

c) 42.5 cm

d) 50 cm

24- Two pistons that are used for lifting a bus of mass 3 tons, the area of each is 0.1 m² , are connected to a third piston acted upon by a force of 200 N. If the three pistons are balanced in the same horizontal level, then the area of the third piston equals .... (g = 10 m/s²)

f

a) 3.325×10^{-4} m²

b) 6.65×10^{-4} m²

c) 1.33×10^{-3} m²

d) 2.66×10^{-3} m²
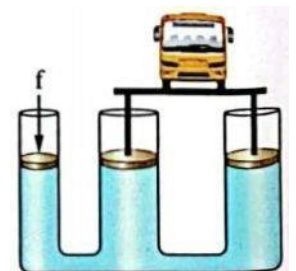
Properties of gaseous materials:

1- Gas molecules are in continuous random motion called "Brownian motion".

2- There are intermolecular spaces between gas molecules, which are very large and not constant.

3-Gases are compressible.

Brownian motion:

It is a group of random motions of fluid particles in all directions for short distances.

★ What are the results of there are large intermolecular spaces between gas molecules?

➡ The motion of the gas molecules is random and the gas becomes compressible.

★ The volume of gas is affected by changing each of pressure or temperature or both.

★ **Gas laws:**

1) Boyle's law ➡ Study the relation between the volume and pressure at constant temperature.

2) Charles's law ➡ Study the relation between the volume and temperature at   constant pressure.

3) Pressure law (Jolly's law) ➡ Study the relation between the pressure and temperature at constant volume.

4) General law of gases ➡ Study the relation between pressure and volume and temperature.

First: Boyle's law:

★ **Boyle's law:**

The volume of fixed mass of a gas is inversely proportional to the pressure, at constant temperature.   **OR**

At constant temperature the product of a certain volume of any given mass of a gas and its pressure is constant.

$$\frac{P_1}{P_2} = \frac{(Vol)_2}{(Vol)_1}$$
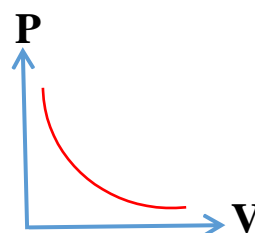
★ $P_1(V_{ol})_1 = P_2(V_{ol})_2 = P_3(V_{ol})_3 = $ **Constant**

★ **G.R: The Volume of air bubble in water increases when it raised to the surface of water.**

➡️ **Because by decreasing the depth the pressure on the bubble decreases, so the volume increases, where** $(P\alpha \frac{1}{V_{ol}})$.

★ **Notes:**

1) If two gases are mixed with each other, we can calculate by using the following the relation:

∴ $(P\ V_{ol})_{mix} = P_1(V_{ol})_1 + P_2(V_{ol})_2$

2) If there is air bubble under water surface then it raised at the surface of water at constant temperature:

∴ $P_1(V_{ol})_1 = P_2(V_{ol})_2$

∴ $(Pa + \rho\ g\ h)\ (V_{ol})_1 = Pa\ (V_{ol})_2$

$(Pa = 1.013 \times 10^5\ N/m^2)$

3) If a capillary tube containing a column of mercury of length (h) trapped a certain volume of air of length (L):

When the tube is placed horizontally then held vertically with the open end downwards and another time upwards:

1) $P_1(V_{ol})_1 = P_2(V_{ol})_2$

2) Pa L_1 = (Pa – h) L_2

3) Pa L_1 = (Pa + h) L_2

(Pa = 76 cm Hg)

(1) (2) (3)
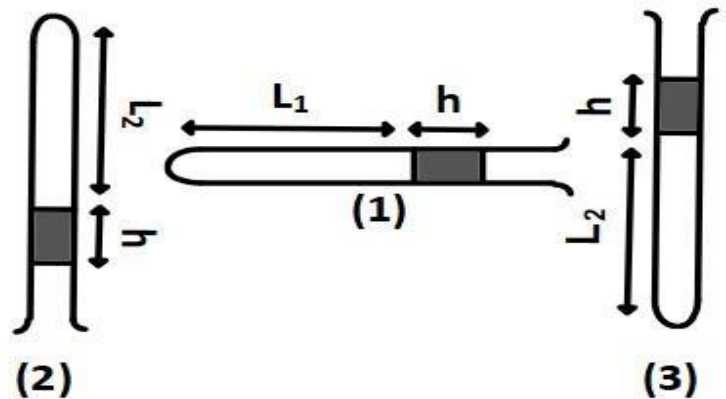
Class Sheet

1- The volume of a certain amount of a gas is 300 cm² under a pressure of 20 cm Hg. If its pressure is increased to 60 cm Hg, then its volume at the same temperature equals……………

a) 100 cm^3 b) 200 cm^3

c) 300 cm^3 d) 900 cm^3

2- A certain amount of a gas has a density of 32 g/l at pressure of 760 mmHg and temperature $0°C$, then its density at the same temperature and a pressure of 570 mm Hg becomes…………

a) 12 g/l   b) 18 g/l

c) 24 g/l   d) 30 g/l

3- The opposite figure shows a cylinder of a uniform cross-section closed from both sides and contains a frictionless movable piston trapping two different quantities of a gas on its sides. If the gas pressure on each of the sides of the piston is 80 cm Hg, then the pressure difference on the two sides of the piston when it moves slowly to the middle of the cylinder at constant temperature equals………

a) 40 cm Hg   b) 80 cm Hg

c) 120 cm Hg   d) 160 cm Hg

4- Capillary tube of uniform cross-section contains a mercury thread of length 10 cm trapping a dry air column of length 30 cm when the tube is held vertically with the open end downwards where the atmospheric pressure is 76 cm Hg, then the length of the trapped air column when the tube is positioned horizontally with assuming constant temperature equals…………

a) 23.02 cm   b) 26.05 cm

c) 30 cm   d) 33.95 cm

5- A quantity of nitrogen gas of volume 15 liters at a pressure of 12 cm Hg and another quantity of oxygen gas of volume 10 liters at a pressure of 50 cm Hg are pumped together into an evacuated closed container of capacity 5 liters. If the temperature of the two gases is the same before and after mixing, then the pressure of the mixture equals……………

a) 16 cm Hg   b) 100 cm Hg

c) 136 cm Hg   d) 148 cm Hg

6- A rubber balloon containing air has a volume of 200 cm^3 under a pressure of 121.6 cm Hg. The balloon is put inside a container of capacity 800 cm^3 and the container is sealed. If the balloon is exploded, then the air pressure inside the container (ignore the rubber volume and suppose that the temperature is constant) equals ....(Where: Pa=76 cm Hg)
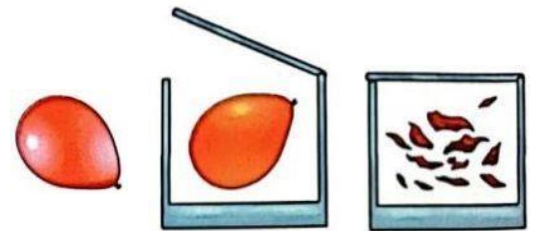
a) 90.7 cm Hg   b) 87.4 cm Hg

c) 76.8 cm Hg   d) 110.2 cm Hg

7- An air bubble rises from a depth of 50 m under the water surface of a lake upward until being at the surface of water where its volume becomes 5 cm^3, so assuming the temperature has remained constant, the volume of the air bubble at the initial depth equals………….

(Knowing that: The density of lake water = 1000 kg/m^3, The acceleration due to gravity (g) = 9.8 m/s^2 and the atmospheric pressure = 1.013 × 10^5 N/m^2)

a) 0.75 cm^3 b) 0.65 cm^3

c) 0.86 cm^3 d) 1.72 cm^3

Homework

1- In the opposite figure, a certain amount of a gas is enclosed inside a cylindrical container of uniform cross-section that is equipped with a movable frictionless piston. Which of the following graphs represents the relation between the pressure of the gas (P) and the length of the enclosed gas column (h) at constant temperature?

Gas

h
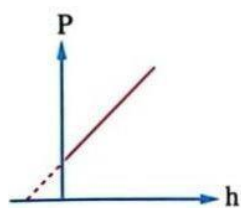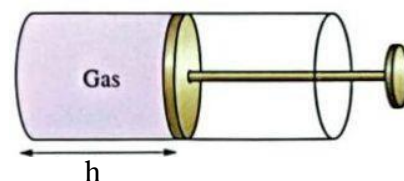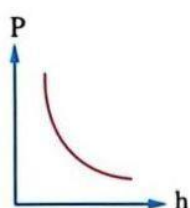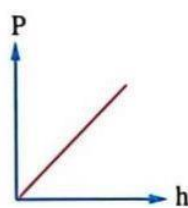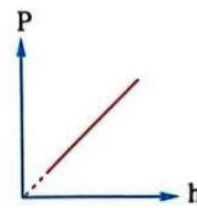
(a)   (b)   (c)   (d)

2- If the volume of a gas is 2 liters at 2 atm, its volume becomes.................. when its pressure decreases to 1 atm at constant temperature.

a) 4 liters   b) 3 liters

c) 1.5 liters   d) 1 liters

3- An amount of a gas of volume 350 cm^3 at pressure of 2 atm, then its volume at the atmospheric pressure (1 atm) at the same temperature is………

a) 350 cm^3 b) 700 cm^3

c) 933 cm^3 d) 1400 cm^3

4- The opposite graph represents the relation between the pressure of an enclosed gas and its volume at constant temperature, so the value of x equals………..

a) 1 m^3 b) 1.2 m^3

c) 1.5 m^3 d) 4 m^3

P(atm)

6

3

0   0.6   x V_{ol} (m³)
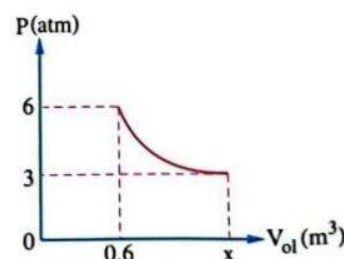
5- Gas bubble of volume V_{ol} at the bottom of a basin containing mercury rises to the surface and just below the surface its volume becomes $\frac{3}{2}V_{ol}$. If the atmospheric pressure is 76 cm Hg, so the height of mercury in the basin is…………

a) 38 cm   b) 49 cm

c) 76 cm   d) 114 cm

6- A certain amount of hydrogen gas occupies a space of 2500 cm³ in the standard pressure and temperature. If the pressure of the gas is increased by $\frac{5}{2}$ of its original pressure. then in this case the gas at the same temperature occupies a space of………..

a) 514.3 cm³   b) 614.3 cm³

c) 714.3 cm³   d) 814.3 cm³

7- The opposite figure shows a movable frictionless piston that traps an amount of gas in a cylinder. The piston was at position (1) and then it is pulled out slowly to position (2) while keeping the temperature constant, so……….
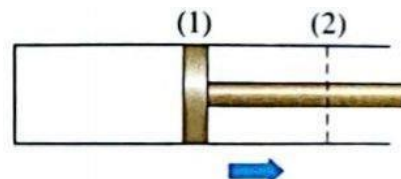
	Gas density	Gas pressure
a	decreases	decreases
b	decreases	remains constant
C	increases	decreases
d	increases	remains constant

8- An amount of a gas of volume V$_{ol}$ at pressure of 2 atm, if its volume gets decreased to 25 % of its original volume at the same temperature, then its pressure becomes………….

a) 2 atm   b) 2.67 atm

c) 4 atm   d) 8 atm

9- A chemist wanted to determine the volume of an evacuated flask, so using a tube of negligible volume, he connected the flask to a reservoir of volume 750 mL that contains a gas of pressure 45 kPa. He found that the pressure inside the flask and the reservoir became 15 kPa at keeping the temperature constant, then the volume of the flask is……………

a) 500 mL   b) 750 mL

c) 900 mL   d) 1500 mL

10- In figure (1), a certain amount of a gas is enclosed inside a cylindrical container which is equipped with a movable frictionless piston where the pressure and the volume of the gas are P_1, and $(V_{ol})_1$ respectively. If the piston is moved upwards very slowly till the volume of the gas becomes $2 (V_{ol})_1$, then which of the curves in figure (2) represents the change in pressure versus volume of the gas at constant temperature?
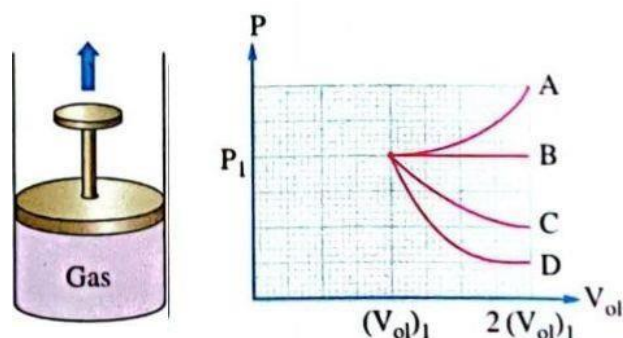
a) A   b) B

c) C   d) D

11- A certain amount of a gas of volume 561 cm³ at temperature 0° C is transferred completely to an evacuated container of volume 748 cm³, hence the pressure becomes 1 atm at the same temperature, then the gas pressure before being transferred was equal to…………….

a) 0.75 atm   b) 1.33 atm

c) 1.5 atm   d) 2 atm

12- In the opposite figure:

A fixed amount of air is trapped inside a cylinder equipped with a movable frictionless piston, when the piston is pulled slowly from position (X) to position (Y) at constant temperature, then the air pressure inside the cylinder………….
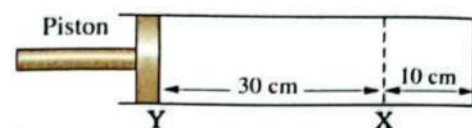
a) decreases to its quarter   b) decreases to $\frac{1}{3}$

c) is tripled   d) quadrupled

13- The figure shows a balloon of volume V_{ol} in a well sealed bell jar made of glass that is connected to a vacuum pump. What happens to the air pressure and the air volume inside the balloon when the pump is operated for few minutes at constant temperature?
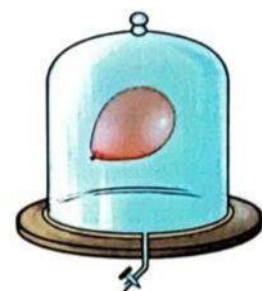
	Balloon volume	The pressure inside the balloon
a	decreases	increases
b	increases	increases
c	increases	decreases
d	decreases	decreases

14- The opposite figure shows Boyle's apparatus where the temperature is kept constant at 20° C during the experiment and the atmospheric pressure is760 mm Hg. When tube A is raised a little upwards, the height difference between the mercury levels inside the two tubes gets increased by 5 cm, then the length of the trapped air column in tube B becomes……..

Tube B
(fixed)   Tube A
           (movable)

12 cm   Trapped
         air   10 cm

                    Mercury

Rubber
tube

a) 11.3 cm   b) 8 cm

c) 11.9 cm   d) 17 cm
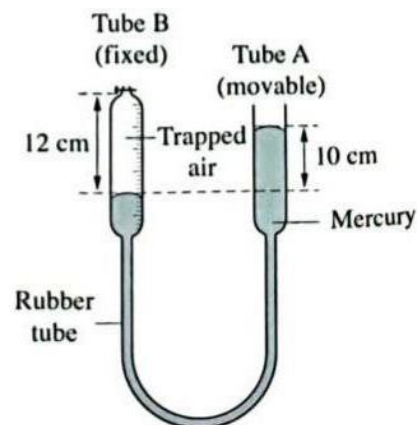
15- In the opposite figure, two well sealed spherical containers A, B which contain two non reacting gases are connected by a horizontal tube of negligible volume that is equipped with a closed valve. If the valve is opened and the total pressure of the mixture of the two gases becomes 780 mm Hg at the same temperature, then the ratio between the volumes of the two containers $\frac{(Vol)_B}{(Vol)_A}$ equals……….

Gas (1)   Gas (2)

$P_1 = 600$ mm Hg $P_2 = 900$ mm Hg
(A)   (B)

a) $\frac{3}{2}$ b) $\frac{2}{1}$

c) $\frac{4}{3}$ d) $\frac{5}{3}$
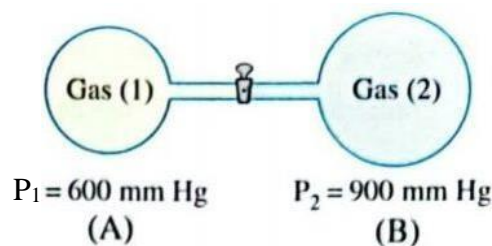
16- A cubic tank of side length l contains a certain amount of an ideal gas at pressure P. If this gas is transferred completely to an evacuated spherical tank of radius l at the same temperature, then pressure of the gas in the spherical tank becomes………..

a) $\frac{4}{3} \pi P$ b) $\frac{3}{4} \pi P$

c) $\frac{3}{4\pi} P$ d) $\frac{P}{\pi}$

17- The opposite graph represents the relation between the pressure (P) and the reciprocal of the volume ($\frac{1}{V_{ol}}$) for a certain amount of a gas at constant temperature, then

(i) The relation that we can deduce from the graph between the pressure and volume is……….

a) $\frac{P}{V_{ol}}$ = constant   b) P V_{ol} = constant

c) $(P V_{ol})^2$ = constant   d) $\frac{P^2}{V_{ol}}$ = constant

$P \times 10^3 (N/m^2)$

400
320
240
160
80

0.1 0.2 0.3 0.4 0.5 $\frac{1}{V_{ol}}$ (m^{-3})
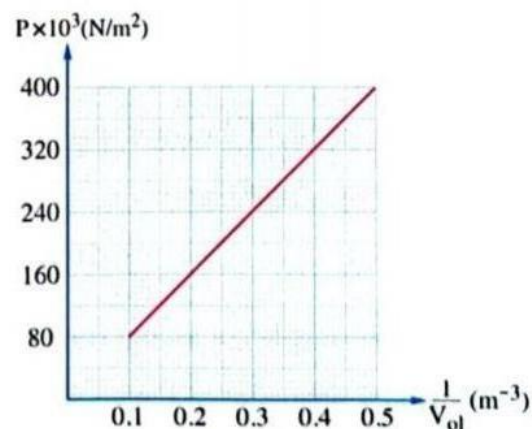
(ii)The volume of the gas when its pressure is 240 kPa equals………..

a) 2.2 m^3

b) 0.3 m^3

c) 3.33 m^3

d) 4.44 m^3

18- In the opposite figure, a cylinder closed from both ends contains a frictionless movable piston at its middle where the gas pressure at the sides of the piston is 75 cm Hg. When the piston is moved slowly upwards using a metal wire of negligible volume, so the upper part volume gets decreased to its half, then the difference in gas pressure at the sides of the piston at constant temperature becures…………..

a) 50 cm Hg

b) 100 cm Hg

c) 150 cm Hg

d) 200 cm Hg
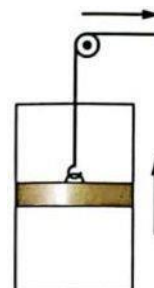
19- The opposite figure represents two positions of a capillary tube of uniform cross-section closed from one end, containing a dry air trapped by a thread of mercury of length 15 cm. If the temperature is constant, then:

(i) The atmospheric pressure equals………..

a) 75 cm Hg

b) 76 cm Hg

c) 76.5 cm Hg

d) 77 cm Hg
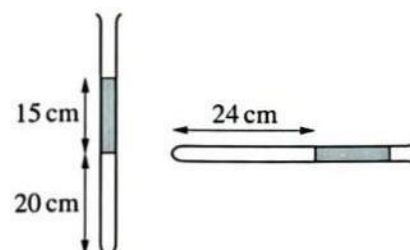
(ii) The length of the trapped air column if the tube is held vertically with its open end downwards equals…………..

a) 10 cm

b) 20 cm

c) 30 cm

d) 40 cm

20- A gas bubble comes out from a breathing tube used by a diver at the bottom of a lake, if the radius of the bubble gets doubled just when it reaches below the surface of water, then the depth of the lake (assuming constant temperature) equals……………

(Where: The atmospheric pressure =1 bar, The density of water = 1000 kg/m^3, The acceleration due to gravity=10 m/s^2)

a) 140 m

b) 105 m

c) 70 m

d) 35 m

21- A quantity of nitrogen gas of volume $\frac{3}{2}V_{ol}$ at pressure P was mixed with a quantity of oxygen gas of volume V_{ol} at pressure 5 P in a closed container of volume $\frac{1}{2}V_{ol}$, then the pressure of the mixture P at the same temperature equals…………..

a) 3.25 P   b) 7 P

c) 13 P   d) 19.5 P

22- In the opposite figure, the bulb at the middle contains an ideal gas at a pressure of 2 atm while the other bulbs are completely evacuated. Suppose that the temperature is constant and the volumes of the connecting tubes are negligible, then the pressure inside the bulb in the middle if:

2 Liters   1 Liter   3 Liters
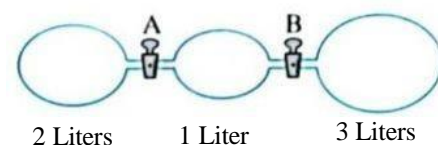
(i) Valve (A) only is opened equals………..

a) $\frac{2}{3}$ atm   b) $\frac{3}{2}$ atm

c) $\frac{1}{3}$ atm   d) $\frac{1}{4}$ atm

(ii) Valves (A) and (B) are opened together……….

a) $\frac{1}{3}$ atm   b) $\frac{1}{2}$ atm

c) $\frac{2}{3}$ atm   d) $\frac{3}{4}$ atm

23- The opposite figure shows a diver who breathes air at the normal atmospheric pressure through a valve in cylinder containing 8 liters of the air under a pressure equals 200 times the normal atmospheric pressure. If the diver needs 16 liters of air per minute at the normal atmospheric pressure, then at constant temperature:

(i) The maximum time can the diver breath below water using that cylinder equals……..

a) 150 minutes   b) 125 minutes

c) 100 minutes   d) 50 minutes

(ii) The volume of the air bubbles due to breathing of the diver increases during its rise to the water surface because of………..

a) decreasing the mass of the air inside the bubble

b) decreasing the water pressure on the bubble

c) increasing the mass of the air inside the bubble

d) increasing the water pressure on the bubble

24- The opposite figure shows two tanks connected through a closed valve on a tube of negligible volume. One of the tanks is evacuated and its volume is (2 V$_{ol}$) while the other tank contains a gas of volume (V$_{ol}$). If the valve between the two tanks is opened slowly, then the pressure of the trapped gas at constant temperature…………..
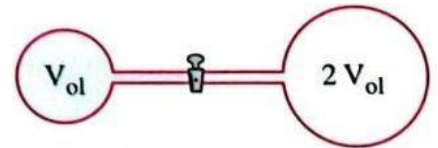
a) decreases to its half   b) increases to the double

c) decreases to its one third   d) increases three times

Second: Charles's law:

-In the opposite experiment when the two flasks heated by the same temperature at constant pressure.

-You notice that the distance moved by the mercury thread are equal in each flask.

-Conclusion:

1) Equal volumes of different gases expand equally when heated through the same temperature at constant pressure.

2) All gases have the same volume expansion coefficient (α_v)
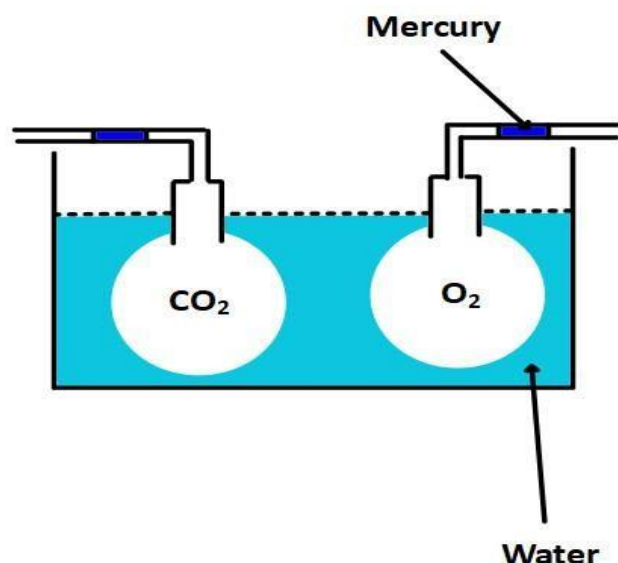
★Deduction of volume expansion coefficient (α_v):

-At constant pressure the increase in volume is directly proportional to:

1- Original volume at (0°C)

$(\Delta V_{ol}) \alpha (V_{ol})0^oC$

2) Increase in temperature (Δt)

$(\Delta V_{ol}) \alpha (\Delta t)$

∴ $(\Delta V_{ol}) \alpha (V_{ol})0^oC . (\Delta t)$

$(\Delta V_{ol}) = $ constant $(V_{ol})0^oC . (\Delta t)$

$(\Delta V_{ol}) = \alpha_v . (\Delta V_{ol})0^oC . (\Delta t)$

$$\therefore \alpha_v = \frac{\Delta (V_{ol})}{(V_{ol})0°C \times (\Delta t)} = \frac{(V_{ol})t - (V_{ol})0°C}{(V_{ol})0°C \times t}$$
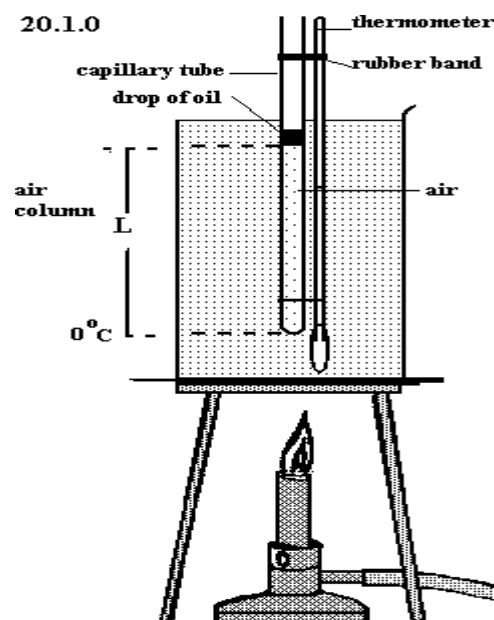
★The measuring unit of (α_v): (Kelvin)$^{-1}$ = (K^{-1})

★ **Volume expansion coefficient of a gas at constant pressure**

It is the increase in volume at constant pressure per unit volume at 0°C for 1°C rise in temperature.

W.M

Volume expansion coefficient of a gas at constant pressure is $\frac{1}{273}$ K^{-1}.

➡ It means that the increase in volume at constant pressure per unit volume at 0°C for 1°C rise in temperature = $\frac{1}{273}$ of the original volume.

★ To convert from Celsius to Kelvin use the following relation:

T = t + 273 , where (T) ➡ Temp. on kelvin , (t) ➡ Temp. on Celsius

★ **G.R: The same volumes of oxygen and nitrogen gases expand equally when heated through the same rise in temperature.**

➡ Because the volume expansion coefficient is constant for all gases at constant pressure.

★ **Charles's experiment:**

-Uses:

1) Verify Charles's law.

2) Determine the volume expansion coefficient of a gas at constant pressure.

-Precautions of the experiment:

1-The tube should be of uniform cross-sectional area.

G.R

➡ Because the length of the trapped air column is a measure of its volume.

2) The trapped air should be completely dry.

➡️ Because the pressure of water vapour changes by changing the temperature and this will affect the accuracy of the measured value of the volume expansion coefficient of air.

3) The atmospheric pressure should be constant during the experiment.

Charles's law:

-At constant pressure, the volume of fixed mass of gas is directly proportional to its temperature on kelvin scale.   **OR**

-At constant pressure the volume of a given mass of gas expands by $\frac{1}{273}$ of its original volume at 0^OC per each degree kelvin rise in temperature.

Graphs
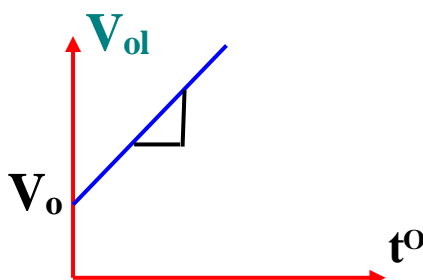
$$\frac{(Vol)_1}{(Vol)_2} = \frac{T_1}{T_2}$$

$$slope = \alpha_v \cdot v_{ol}0°C$$
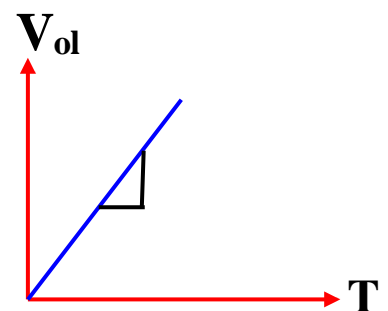
★ **Deduction of the mathematical formula of charles's law:**

∵ (Δ ABC) is similar to (Δ ADE)

∴ $\frac{BC}{AC} = \frac{DE}{AE}$

BC = $(V_{ol})_1$, DE = $(V_{ol})_2$

AC = T_1 ,   AE = T_2

$$\frac{(Vol)_1}{T_1} = \frac{(Vol)_2}{T_2}$$

$$∴ \frac{(Vol)_1}{(Vol)_2} = \frac{T_1}{T_2}$$
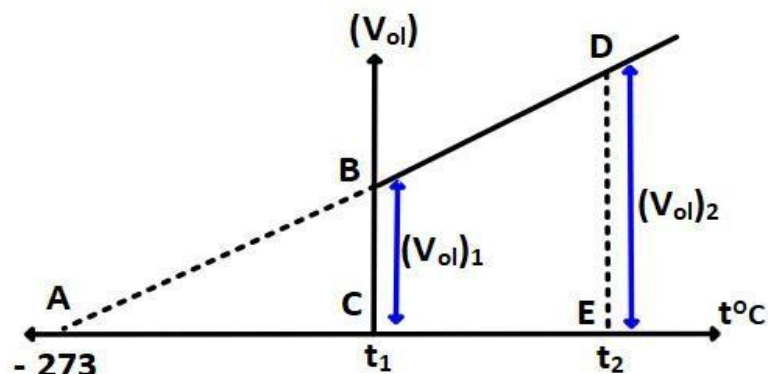
$\because T = t + 273$

$$\frac{(Vol)_1}{(Vol)_2} = \frac{273 + t_1}{273 + t_2} = \frac{1 + \dfrac{1}{273}t_1}{1 + \dfrac{1}{273}t_2}$$

$\because \alpha_v = \dfrac{1}{273}$

$$\therefore \frac{(Vol)_1}{(Vol)_2} = \frac{1 + \alpha_v t_1}{1 + \alpha_v t_2}$$

★ **Note: If two gases are mixed at constant pressure, then:**

$$\left(\frac{(Vol)}{T}\right)_{mix} = \frac{(Vol)_1}{T_1} + \frac{(Vol)_2}{T_2}$$

Class Sheet

1- A quantity of gas has a volume (V$_{ol}$)$_{0°C}$ at temperature 0°C. When its temperature increases to 273°C, its volume becomes 100 L. If you know that the volume expansion coefficient of the gas at constant pressure is $\dfrac{1}{273}$ K^{-1}, then the volume of that quantity of the gas at 0°C equals………..

a) 40 L   b) 50 L

c) 59 L   d) 100 L

2- If the volume of an amount of a gas is 450 cm^3 at 273 K and pressure 76 cm Hg, then its volume at 364 K assuming that its pressure remains constant equals…………

a) 400 cm^3 b) 600 cm^3

c) 680 cm^3 d) 760 cm^3

3- An open flask of inner volume 2.05 liters is placed in a fridge at 5° C, if it is taken out of the fridge and left until its temperature became 21° C, then the volume of the leaked air from the flask by assuming the persistence of both of the pressure and the volume of the flask equals ………..

a) 0.12 L   b) 0.15 L

c) 0.18 L   d) 0.2 L

4- An amount of a gas of volume 50 liters at temperature of 273 K and pressure of 76 cm Hg, when it is heated to 546 K, its pressure is decreased to 60.8 cm Hg and its volume becomes 125 liters, then the volume expansion coefficient under a constant pressure equals………..

a) $\dfrac{1}{276}$ K^{-1}

b) $\dfrac{1}{275}$ K^{-1}

c) $\dfrac{1}{274}$ K^{-1}

d) $\dfrac{1}{273}$ K^{-1}

5- A certain amount of a gas has a volume of 35 cm³ at 27° C, if its volume becomes 40.6 cm³ at 75° C, then the volume expansion coefficient of this gas at constant pressure equals……..

a) 2.6×10^{-3} K^{-1}

b) 3×10^{-3} K^{-1}

c) 3.56×10^{-3} K^{-1}

d) 3.66×10^{-3} K^{-1}

6- A certain amount of gas has density 1.3 kg/m³ and volume 50 cm³ at 0°C, then the density of the gas when its temperature increases by 50 K at constant pressure equals…………

a) 0.9 Kg/m^3

b) 1.1 Kg/m^3

c) 1.3 Kg/m^3

d) 1.9 Kg/m^3

<mark>**Homework**</mark>

1- The graph that represents Charles's law for the ideal gas is…………….

(a)　　　　(b)　　　　(c)　　　　(d)
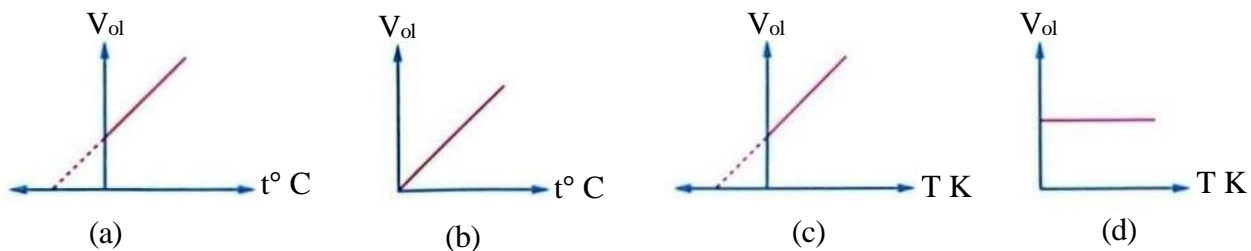
2- If the temperature of a gas is increased by 10°C,then this rise in temperature on the Kelvin scale equals………….

a) 10 K

b) 263 K

c) 273 K

d) 283 K

3- An amount of a gas has a volume of 600 cm³ at 293 K, then its volume at a temperature of 333 K at constant pressure will be………..

a) 527.9 cm³ 　　　　　　b) 681.9 cm³

c) 722.5 cm³ 　　　　　　d) 778.4 cm³

4- The volume of a quantity of gas is 4 liters at temperature of 120° C, then the change in its temperature in kelvin when its volume decreases to 1 liter at the same pressure is …………

a) 294.75 K 　　　　b) 366 K

c) 393 K 　　　　d) 491.25 K

5- A quantity of a gas at temperature of 17° C is heated to increase its temperature by 100° C at the same pressure, so its volume has increased by 2.5 cm³, then the volume of the gas before heating is ……..

a) 4.25 cm³ 　　　　　　b) 7.25 cm³

c) 14.25 cm³ 　　　　　　d) 323.03 cm³

6- An amount of a gas has volume V_{ol} at temperature T. When we increase its temperature by ΔT, its volume increases by ΔV_{ol} at constant pressure. Then the graph representing the relation between the volume expansion coefficient of the gas and its absolute temperature at constant pressure is…………

(a)　　　　　　(b)　　　　　　(c)　　　　　　(d)

7- The volume of a certain amount of a trapped gas at 10° C gets doubled when it is heated to ………… at constant pressure.

a) 20° C 　　　　b) 50° C

c) 100° C 　　　　d) 293° C

8- If the volume of a certain amount of a gas at temperature 44° C is 250 cm³, then at temperature of 0° C its volume at constant pressure becomes………..

a) 320 cm³   b) 300 cm³

c) 215 cm³   d) 200 cm³

9- To determine the volume expansion coefficient of a gas at constant pressure, an experiment is carried out using a vertical capillary tube of regular cross-sectional area containing a mercury thread trapping an air column. The opposite table illustrates the values of the length of air column at different temperatures, the value of t_2, at constant pressure is about………

Length of the air column(cm)	Temperature (°C)
50	25
60	t_2

a) 30° C   b) 35° C

c) 45° C   d) 85° C

10- A gas of volume 60 cm³ at temperature 300 K and pressure 1 atm, its volume becomes 36.4 cm³ at temperature 0°C and pressure 1.5 atm, then the volume expansion coefficient under a constant pressure equals……….

a) 3.66×10^{-3} K⁻¹   b) 4.33×10^{-3} K⁻¹

c) 4.63×10^{-3} K⁻¹   d) 6.33×10^{-3} K⁻¹

11- If the length of the trapped air column in a vertical capillary tube of uniform cross-sectional area is 39 cm at a temperature of 273 K and when the temperature rises to 378 K the length of the air column becomes 54 cm, then the volume expansion coefficient with neglecting the expansion of the tube at constant pressure equals…………

a) $\frac{1}{276}$ K⁻¹   b) $\frac{1}{275}$ K⁻¹

c) $\frac{1}{274}$ K⁻¹   d) $\frac{1}{273}$ K⁻¹

12- In Charles's experiment for determining the volume expansion coefficient for air under constant pressure, the length of the enclosed air column at the melting point of ice was 13.65 cm and the length of the air column at the boiling point of water under the standard atmospheric pressure at sea level was 18.65 cm, then with assuming that the pressure remains constant and neglecting the expansion of glass, the volume expansion coefficient of air equals……..

a) $2.66 \times 10^{-3} \text{ K}^{-1}$ b) $3.66 \times 10^{-3} \text{ K}^{-1}$

c) $14.66 \times 10^{-3} \text{ K}^{-1}$ d) $23.54 \times 10^{-3} \text{ K}^{-1}$

13- If the percentage of the change in the volume of a certain amount of a gas at heating is 10% of its original volume at constant pressure, then the percentage of the change in its absolute temperature equals………..

a) 10 %   b) 20 %

c) 80 %   d) 90 %

14- An amount of air of mass 0.2 kg is trapped in a container equipped with a frictionless movable piston. If the density of air is 1.3 kg/m³ at 0° C, the volume of the trapped air when rising the temperature of the container to 120° C at the same pressure equals…………..

a) 0.11 m^3 b) 0.22 m^3

c) 0.29 m^3 d) 0.44 m^3

15- A capillary tube of uniform cross-section and length 15 cm is placed vertically and contains amount of air trapped by a mercury column of length 5 cm while the length of the trapped air column is 9.1 cm at 21° C, then the maximum temperature in Celsius that can be determined when using the tube as a thermometer with assuming that pressure is constant and neglecting the expansion of the tube equals……………

a) 50° C   b) 75° C

c) 90° C   d) 125° C

16- The temperature of a quantity of a gas is increased from 37° C to 192° C at constant pressure. If the volume of this amount of the gas at 37° C is V_{ol}, then the change in the volume of the gas (ΔV_{ol}) equals……….

a) $\frac{V_{ol}}{4}$ b) $\frac{V_{ol}}{3}$

c) $\frac{V_{ol}}{2}$ d) V_{ol}

17- An opened metal can contains a certain amount of air of volume V_{ol} at temperature 298 K. When the can is heated to a temperature of 343 K, a volume of 9.06 cm³ of air is leaked from the can. By ignoring the expansion of the can, then at constant pressure the value of V_{ol}, is……….

a) 40 cm^3 b) 50 cm^3

c) 60 cm^3 d) 67 cm^3

18- An open flask containing air is heated from temperature of 15°C to 87°C, then the ratio between the volume of air that went out of the flask to the original volume of air that was in the flask considering the pressure is constant and the expansion of the flask is negligible is………

a) 0.125   b) 0.25

c) 0.3   d) 0.4

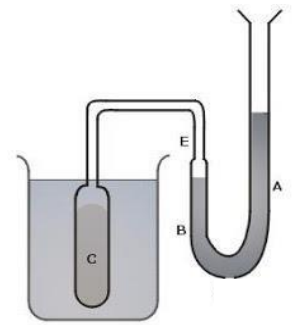**19- An amount of air of volume 5460 cm^3 at temperature of 0°C is trapped in a cylinder of cross-sectional area 250 cm^2 that has a frictionless movable piston. If the cylinder is heated until the temperature of air becomes 100° C, then by neglecting the expansion of the cylinder, the distance moved by the piston to keep the pressure constant is………**

a) 4 cm   b) 8 cm

c) 12 cm   d) 16 cm

Third: Jolly's law (Pressure law):

-The opposite figure shows:

1) Flask contain a fixed volume of gas (Air).

2)U-shaped tube has a suitable amount of mercury

connected to the flask.

-If you change the temperature of the gas in flask you
observe that the pressure will change where by increasing
the temperature the pressure increases and vice versa.

Constant volume gas thermometer

-If you use different gases then heated by the same temperature in each time,
you observe that the pressure will change by the same amount each time.

-Conclusion:

1)At constant volume the pressure of a fixed mass of gas is directly proportional
to the temperature.

2)At constant volume the pressure of different gases increases equally when
heated to the same temperature.

G.R

-Because the pressure expansion coefficient for any gas at constant volume is
constant.

Deduction of pressure expansion coefficient(β_P):

-At constant volume the increase in pressure (ΔP) is directly proportional to :

(a) Original pressure at 0^oC (P_O) $\Longrightarrow$ $\Delta P \propto P_{0^oC}$

(b) Increase in temperature (Δt) $\Longrightarrow$ $\Delta P \propto \Delta t$

$\therefore \Delta P \propto P_{0^o} C \Delta t$ $\Longrightarrow$ $\Delta P = $ constant $P_{0^oC} \Delta t$

$$\therefore \Delta P = $$

$$\therefore \beta_P = \frac{\Delta P}{P_0{}^OC .t} = \frac{P_t - P_0{}^OC}{P_0{}^OC \times \Delta t}$$

Measuring unit of pressure expansion coefficient is: (Kelvin)$^{-1}$ = (K^{-1})

The pressure expansion coefficient of a gas at constant volume (β_P)

It is the increase in pressure of a gas per unit pressure at 0°C when the temperature increases 1°C at constant volume.

W.M: The pressure expansion coefficient of a gas $= \dfrac{1}{273} \, k^{-1}$

➡️ It means that the increase in pressure of the gas per unit pressure at 0°C when the temperature increases 1°C at constant volume equals $\dfrac{1}{273}$ of the original pressure.

G.R: The pressure expansion coefficient of a gas is constant at constant volume.

➡️Because equal pressures of different gases increases equally when rising their temperature by equal amounts at constant volume.

Jolly's experiment:

Uses:

1) To measure the pressure expansion coefficient of a gas at constant volume.

2) Verify Jolly's law.

Precautions of the experiment:

1) $\dfrac{1}{7}$ of the volume of the gas bulb should be filled with mercury.   G.R

➡️-To keep the volume of the enclosed gas constant during the experiment as the temperature changes such that the volume expansion coefficient of mercury is 7 times that of the glass.

2) The bulb of jolly's apparatus must be dry from inside.   G.R

➡️Because any drop of water change by heat into water vapour so that the value of the pressure will change and we can't determine the value of the pressure expansion coefficient correctly.

-The pressure of a given mass of a gas kept at constant volume increases by $\frac{1}{273}$ of its original pressure at $0^{\circ}C$ per each degree kelvin rise in temperature.   **(OR)**

At constant volume, the pressure of fixed mass of gas is directly proportional to its temperature on Kelvin scale.

∵ **(Δ ABC) is similar to (Δ ADE)**

∴ $\dfrac{BC}{AC} = \dfrac{DE}{AE}$

∴ $\dfrac{P_1}{T_1} = \dfrac{P_2}{T_2}$ ⟹ $\boxed{∴ \dfrac{P_1}{P_2} = \dfrac{T_1}{T_2}}$

∴**P α T**

From the previous relation:

∵ $\dfrac{P_1}{P_2} = \dfrac{T_1}{T_2}$, T =273+t

∴ $\dfrac{P_1}{P_2} = \dfrac{273+t_1}{273+t_2}$

∴ $\dfrac{P_1}{P_2} = \dfrac{1+\frac{1}{273}t_1}{1+\frac{1}{273}t_2}$, ∵ $\beta_p = \dfrac{1}{273}$ $\boxed{∴ \dfrac{P_1}{P_2} = \dfrac{1+\beta_P t_1}{1+\beta_P t_2}}$
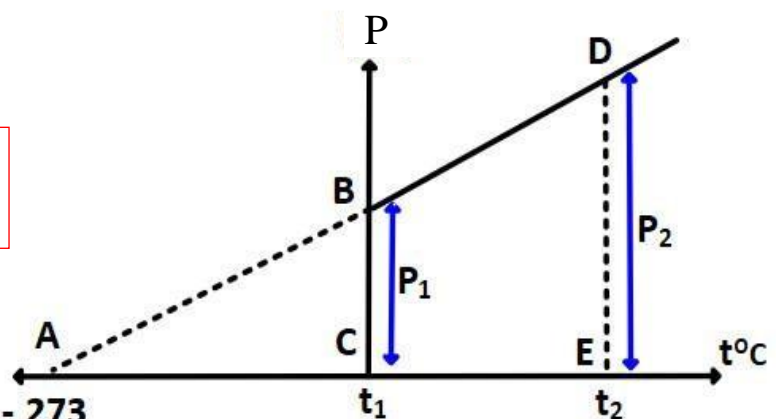
-It is the temperature at which the volume of an ideal gas vanishes theoretically at constant pressure.   **OR**

-It is the temperature at which the pressure of an ideal gas vanishes theoretically at constant volume.

Fourth: General gas law:

-from Boyle's law (V_{OL} α $\frac{1}{P}$) & From Charles's law (V_{ol} α T)

∴ V_{ol} α $\frac{T}{P}$ ⟹ ∴ V_{ol} = Constant × $\frac{T}{P}$

∴ $\frac{PV}{T}$ = $Constant$ ⟹ ∴ $\frac{P_1(Vol)_1}{T_1} = \frac{P_2(Vol)_2}{T_2}$

If the density changes $\frac{P_1}{\rho_1 T_1} = \frac{P_2}{\rho_2 T_2}$ ⟹ At constant mass.

If the mass changes $\frac{P_1}{m_1 T_1} = \frac{P_2}{m_2 T_2}$ ⟹ At constant volume.

If two gases mixed then $\left(\frac{PVol}{T}\right)_{mix.} = \frac{P_1(Vol)_1}{T_1} + \frac{P_2(Vol)_2}{T_2}$

(S .T .P) meaning   P =1.013 × 10^5 N/m²   T = 273°k

Class Sheet

1- If the pressure of a certain amount of a gas at 0° C is 33 cm Hg and when the temperature increases to 182° C at constant volume, its pressure becomes 55 cm Hg,then the pressure increasing coefficient of the gas at constant volume equals…………..

a) $\frac{1}{373}$ K^{-1}

b) $\frac{1}{275}$ K^{-1}

c) $\frac{1}{274}$ K^{-1}

d) $\frac{1}{273}$ K^{-1}

2- If the pressure of a certain amount of a gas is 3 atm at 30°C and when the gas temperature is decreased to −172°C, its pressure becomes equal to the atmospheric pressure, then the pressure increasing coefficient of the gas at constant volume equals.........   (where Pa = 1 atm)

a) $100 \ K^{-1}$ b) $273 \ K^{-1}$

c) $\dfrac{1}{373} \ K^{-1}$ d) $\dfrac{1}{273} \ K^{-1}$

3- If the pressure of 20 cm³ of a gas at 26°C is 59.8 cm Hg, then its pressure at 130℃, assuming that the volume is constant equals……….

a) 44.37 cm Hg   b) 59.8 cm Hg

c) 61.7 cm Hg   d) 80.6 cm Hg

4- A manometer is connected to a tank which contains a quantity of gas at 10°C whose pressure is greater than the atmospheric pressure by 10^5 Pa. If the temperature of the gas is raised to 40°C, so the increase in the pressure of the gas considering that the volume is kept constant, is…………

a) 1.87×10^2 Pa   b) 3.35×10^2 Pa

c) 2.13×10^4 Pa   d) 6.3×10^4 Pa

5- The pressure of a gas that occupies a volume of 250 cm³ is 1 atm at 27°C, then the pressure of this gas at 177°C when its volume is 300 cm³ equals……..

a) 0.83 atm   b) 1.25 atm

c) 1.35 atm   d) 1.75 atm

6- The volume of a gas at 27°C under pressure of 60 cm Hg is 380 cm³, then its volume at the standard temperature and pressure (STP) equals………..

a) $273 \ cm^3$ b) $333 \ cm^3$

c) $346 \ cm^3$ d) $546 \ cm^3$

7- The opposite graph shows the relation between the pressure (P) for two equal masses of the same gas at different volumes ($(V_{ol})_1$, $(V_{ol})_2$) and the temperature(T)on the Kelvin scale, then ....
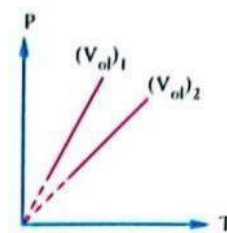
a) $(V_{ol})_1 = (V_{ol})_2$ b) $(V_{ol})_1 > (V_{ol})_2$

c) $(V_{ol})_1 < (V_{ol})_2$ d) the answer is indeterminable

8- An air bubble of volume 0.25 cm³ is at the bottom of a lake where the temperature is 5℃. If the depth of the lake is 10 m, then the volume of the bubble just before it reaches the surface where the temperature of water is 20°C equal...........

(where: $Pa = 10^5$ N/m² , $\rho_w = 1000$ Kg/m³ , g = 10 m/s²)

a) 0.27 cm³   b) 0.36 cm³

c) 0.53 cm³   d) 0.69 cm³

9- If the density of an amount of oxygen gas of volume V_{ol} is 1.43 kg/m³ at ST'P, then the density of this amount of oxygen gas at 35°C under a pressure of 2×10^5 N/m² equals.....

(where: $Pa = 1.013 \times 10^5$ N/m²)

a) 1.43 Kg/m³   b) 2.5 Kg/m³

c) 3.6 Kg/m³   d) 1.95 Kg/m³

<mark>Homework</mark>

1- What is the temperature at which the pressure of an amount of a gas at 10°C gets doubled at constant volume?

a) 20°C   b) 80°C

c) 160°C   d) 293°C

2- When a certain amount of a gas is heated, which of the following graphs represents the change in pressure(P)when the temperature(t) on the Celsius scale changes at constant volume?

P   t°C   (a)   P   t°C   (b)   P   t°C   (c)   P   t°C   (d)
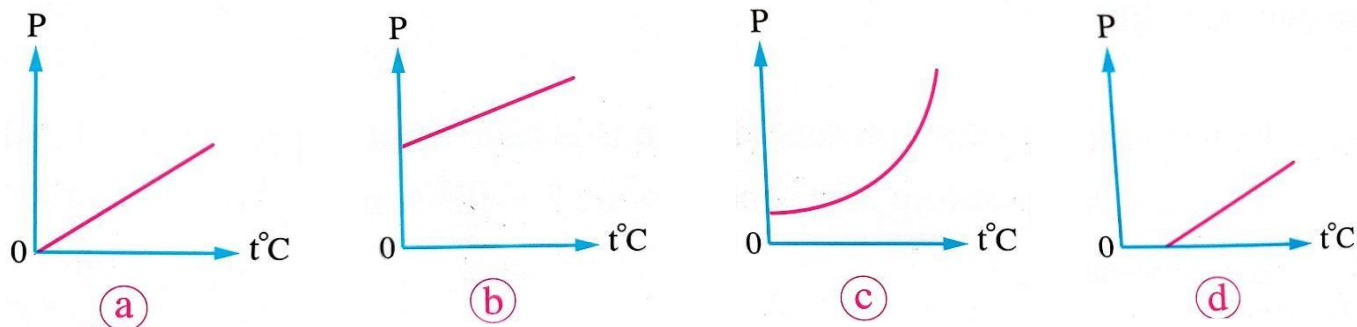
3- A closed container containing air at 0°C is cooled to (- 91°C), so its pressure becomes 40 cm Hg. Then, neglecting the contraction of the container by cooling, the pressure of air at 0°C equals……….

a) 20 cm Hg   b) 40 cm Hg

c) 60 cm Hg   d) 80 cm Hg

4- Test tube is closed at STP, if its temperature is increased to 300°C supposing that the volume of the gas is constant, then the pressure of the gas in cm Hg equals………

a) 96.6 cm Hg   b) 115.4 cm Hg

c) 135.6 cm Hg   d) 159.5 cm Hg

5- The pressure of a certain amount of a gas is P at temperature 5°C and it becomes 75 cm Hg when the temperature of the gas is increased by 20°C at the same volume, then the value of P equals……….

a) 51.5 cm Hg   b) 69.97 cm Hg

c) 75 cm Hg   d) 80.4 cm Hg
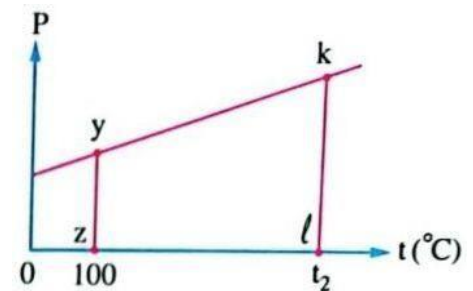
6- The opposite graph represents the relation between the pressure P of a certain mass of a gas and its temperature in Celsius t°C at constant volume, then the slope of the straight line equals......
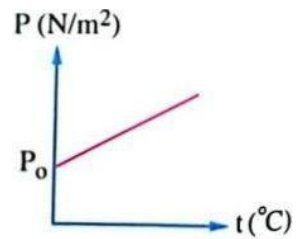
P (N/m²)

a) P_o

b) $\dfrac{P_o}{273}$

c) $\dfrac{273}{P_o}$

d) $273\ P_o$

7- The opposite graph represents the relation between the pressure (P) of a certain mass of a gas and its temperature in Celsius (t°C), so if the ratio between the lengths of the sides $\dfrac{Kl}{Yz}$ is $\dfrac{2}{1}$, then the value of t_2 equals...........

a) 200°C

b) 315°C

c) 437°C

d) 473°C

8- If the temperature of a certain amount of a gas in (STP) is changed, so its pressure gets increased by $\dfrac{5}{2}$ of its original pressure at constant volume, then this means that the temperature of the gas on the Kelvin scale.........

a) decreases to its half

b) increases to 1.5 times

c) doubles

d) increases to 3.5 times

9- The opposite graph represents the relation between the pressure (P) of a certain mass of an ideal gas and its temperature in Celsius (t°C) at constant volume, so if the pressure of that gas at 50°C equals P_1, then its pressure (P_o) at 0°C is approximately equal to.........

P cm Hg

a) $0.22\ P_1$

b) $0.35\ P_1$

c) $0.65\ P_1$

d) $0.85\ P_1$

10- In the opposite figure a well sealed glass flask contains an ideal gas. When the gas is heated, the temperature of the gas on Kelvin scale increased to the double and its pressure increased by 20 cm Hg, so the gas pressure before heating was………

a) 20 cm Hg

b) 40 cm Hg

c) 60 cm Hg

d) 80 cm Hg

11- If the volume of a certain amount of an ideal gas is decreased to half and its temperature in kelvins raised to its double, so the gas pressure becomes ……… its original pressure.

a) double

b) 3 times

c) 4 times

d) half

12- The gas leak from a cylinder with an opened valve stops when the pressure inside the cylinder becomes…………..

a) greater than the atmospheric pressure

b) less than the atmospheric pressure

c) equal to the atmospheric pressure

d) the answer is indeterminable

13- An amount of a gas of volume 76 cm³ at pressure 325 cm Hg and temperature 52°C, then its volume at STP equals…………..

a) 273 cm³

b) 364 cm³

c) 455 cm³

d) 546 cm³

14- The opposite graph represents the relation between the volume (V$_{ol}$) for two equal masses of two different gases A and B of pressures P$_A$, P$_B$ respectively and their temperature (T) in Kelvin, then…………

a) P$_A$ = P$_B$

b) P$_A$ > P$_B$

c) P$_A$ < P$_B$

d) the answer is indeterminable

15- An air bubble has a volume of 0.5 cm³ at a depth of 10.13 m beneath the water surface where the temperature at that depth is 4°C, then its volume just before reaching the surface of water where the temperature is 22°C is……….

**(Where: g=10 m/s², Pa=1.013 × 10⁵ pascal, Water density = 1000 Kg/m³)**

a) 0.25 cm³　　　　　　　　b) 0.5 cm³

c) 0.75 cm³　　　　　　　　d) 1.06 cm³

16- A certain mass of a gas occupies a space of 2 L at pressure of 100 kPa and temperature of 27°C, then the temperature at which each of the volume and the pressure of the gas becomes half its original value is…………..

a) 75 K　　　　　　　　　b) 75°C

c) 13.5 K　　　　　　　　d) 13.5°C

17- The opposite figure shows two bulbs x, y, each of them contains dry air at the same temperature and they are joined by a capillary tube that contains a mercury thread. If the temperature of the gas is increased in the two bulbs by the same amount, then the mercury thread………..

Mercury thread

V_{ol}　　　　V_{ol}

x　　　Dry air　　　y

a) moves to the right　　　　　b) moves to the left

c) doesn't move　　　　　　　d) decreases in size
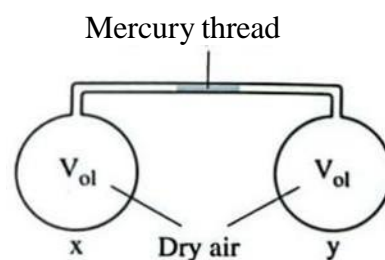
18- Amount of a gas of volume 82.6 cm³ at a pressure of 640 mm Hg and temperature of 25°C, if the gas density at STP is 0.09 kg/m³, then the mass of that amount equals………….

a) 1.18×10^{-6} Kg　　　　　　b) 5.73×10^{-6} Kg

c) 8.4×10^{-6} Kg　　　　　　d) 11.9×10^{-6} Kg

19- When a gas leaks from a cylinder with open valve, then…………..

a) the pressure of the remaining gas inside the cylinder vanishes

b) the volume of the remaining gas inside the cylinder increases

c) the volume of the remaining gas inside the cylinder decreases

d) the density of the remaining gas inside the cylinder decreases

20- An air bubble has a volume of 0.2 cm³ at a depth of 15 m beneath the water surface of a salty lake where the temperature at that depth is 4°C, then its volume just before reaching the surface of water where the temperature is 24°C is………..

(Where: g=10 m/s², Pa=1.013 × 10⁵ pascal, Salty water density = 1030 Kg/m³)

a) 0.27 cm³   b) 0.39 cm³

c) 0.54 cm³   d) 1.79 cm³